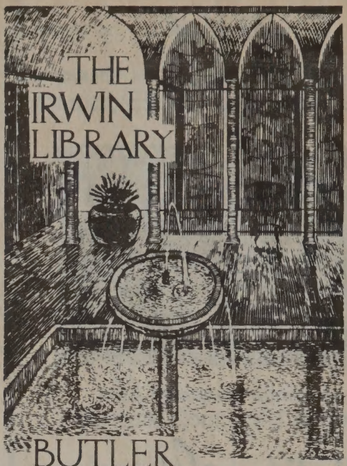


THE
IRWIN
LIBRARY
BUTLER
UNIVERSITY

THE AMATEUR MECHANIC

THE AMATEUR MECHANIC

A PRACTICAL GUIDE FOR THE HANDYMAN

EDITED BY
BERNARD E. JONES
EDITOR OF "WORK"

NEW, ENLARGED EDITION REARRANGED AND ENTIRELY RESET

With Thousands of Photographs and Drawings

Vol. III

PROPERTY OF
Butler University
LIBRARY

G. P. PUTNAM'S SONS
PUBLISHERS NEW YORK

The Index to all Four Volumes will be found at the end of Vol IV

Printed in Great Britain

TJ
7
.A42
V.3

Contents

PAGE
LOCKS: THEIR VARIETY, FITTING AND REPAIRING (88 *Illustrations*) . . . 1
A SELF-CLOSING DOOR (1 *Illustration*) 31
PAPERHANGING (13 *Illustrations*) 32
BUILDING MODEL AEROPLANES (28 *Illustrations*) 43
HOW TO MAKE A COPPER LID (4 *Illustrations*) 51
RESTORING AN OLD ELM TABLE (20 *Illustrations*) 53
SQUARE HANGING BASKETS (3 *Illustrations*) 61
MAKING A CHILD'S FOLDING CAR (12 *Illustrations*) 62
WATCH CLEANING AND REPAIRING (57 *Illustrations*) 64
HOW TO MAKE ARTIFICIAL MARBLE (7 *Illustrations*) 87
A BAMBOO MONEY-BOX (2 *Illustrations*) 90
REPAIRING SPECTACLES (9 *Illustrations*) 91
FROSTING GLASS 94
BOOT REPAIRING: SOLING AND HEELING (42 *Illustrations*) 95
AQUARIUMS, AND HOW TO MAKE THEM (28 *Illustrations*) 118
HOW TO MAKE A MATTRESS (22 *Illustrations*) 124
ALTERING GAS-FITTINGS TO TAKE INVERTED BURNERS (4 *Illustrations*) . . 133
RE-STRINGING A TENNIS RACKET (3 *Illustrations*) 134
FIXING PICTURE RODS AND RAILS (12 *Illustrations*) 136
CLEANING STONEWORK AND BRICKWORK 138
SIMPLE WOOD-TURNING (74 *Illustrations*) 139

CONTENTS

PAGE
MAKING CELLULOID VARNISH (1 *Illustration*) 159
CLEANING AND RESTORING OIL PAINTINGS 161
ELECTROTYPING 164
SEWING MACHINES: REPAIRS AND ADJUSTMENTS (2 *Illustrations*) . . . 166
WOOD INLAYING (36 *Illustrations*) 171
WHITE ENAMEL FINISH ON FURNITURE 185
ORANGE-CUTTING MACHINE FOR MAKING MARMALADE (4 *Illustrations*) . . 186
REPRODUCING COINS AND CAMEOS IN PLASTER 188
RUSTIC FURNITURE FOR THE GARDEN (45 *Illustrations*) 189
THE SIPHON: HOW IT WORKS (2 *Illustrations*) 200
RE-HAIRING VIOLIN BOWS (1 *Illustration*) 201
A GARDEN FRAME MADE IN SECTIONS (9 *Illustrations*) 203
ELECTRIC POLE FINDERS 208
AIR-GAS: WHAT IT IS, AND HOW TO MAKE THE PLANT (13 *Illustrations*) . 209
RENEWING BROKEN SASH CORD (3 *Illustrations*) 224
SIMPLE BRICKLAYING (40 *Illustrations*) 226
PRACTICAL NOTES ON GEYSERS (2 *Illustrations*) 241
RENOVATING A GRANDFATHER CLOCK (43 *Illustrations*) 243
FRENCH POLISHING (4 *Illustrations*) 254
REMEDYING DAMP WALLS 260
BIRDCAGES AND AVIARIES (38 *Illustrations*) 261
A SUNDIAL PEDESTAL IN BRICKWORK (4 *Illustrations*) 267
REPAIRING AND GRINDING SCISSORS (14 *Illustrations*) 269
BENT-IRON WORK (73 *Illustrations*) 273
MAKING INCANDESCENT GAS-MANTLES 284
INCORRODIBLE PAINTS OR INKS 286
BOOT REPAIRING: MANY VARIED OPERATIONS (22 *Illustrations*) . . . 287
COLOURING VARIOUS METALS 304

PAGE
Home-made Drilling Machines (28 *Illustrations*) 312
Galvanising 317
Repairing Leaky Roofs 318
Testing Metals by Touchstone 319
Thatching a Roof (4 *Illustrations*) 321
Gauges for Wire and Sheet-metal (17 *Illustrations*) 323
Grinding, Setting, and Stropping Razors (11 *Illustrations*) . . . 329
Treillage and Trellis-work (47 *Illustrations*) 333
Wardrobe Door Not Closing 341
Boat Building (39 *Illustrations*) 342
Fitting Carpet on Stairs 359
Making Induction Coils (12 *Illustrations*) 360
Repairing Worm-eaten Chairs (1 *Illustration*) 368
Casting in Plaster and Cement (26 *Illustrations*) 369
Care in Preparing Glue 377
Laying Linoleums and Mattings (15 *Illustrations*) 378

Locks: Their Variety, Fitting and Repairing

In this chapter will be given general information on the kinds of locks and latches in common use, together with instructions on fitting and fixing them. Photographs of the various locks met with in the ordinary household will be presented, and the details of the mechanisms made clear. The repair and adjustment of locks, from the locksmith's as well as the carpenter's point of view, will be dealt with, and notes will be included on key cutting and lock picking. The chapter will conclude with an explanation of how to make a letter lock of the padlock type.

VARIOUS HOUSEHOLD LOCKS AND HOW TO FIT THEM

Mortise Locks.—These (see Figs. 1 and 2) are used on all or most of the interior doors of the better class of houses, and are almost entirely concealed when fixed. The fore-end or visible part of one lock is as like to another as two peas, yet the one may have cost fourteen pence and the other several shillings.

A good ordinary mortise lock has two gunmetal bolts, gunmetal bushes around the follower and pin of the keyhole, duplicate springs, two levers, and a reversible latch bolt so as to suit doors hung on the right- or left-hand side of frames. It will be of sound construction throughout, yet not so thick as to weaken the door by excessive mortising. It will, in most cases, contain patented improvements by the maker of a special character, such as anti-friction follower, peculiar form of spring or bolt, resulting in an easy and silent action, or such like. Many locks are made with a semicircular end to effect a saving of time in the fixing. The chief objection urged against the use of mortise locks is the necessity for cutting away a portion of the lock rail, thus

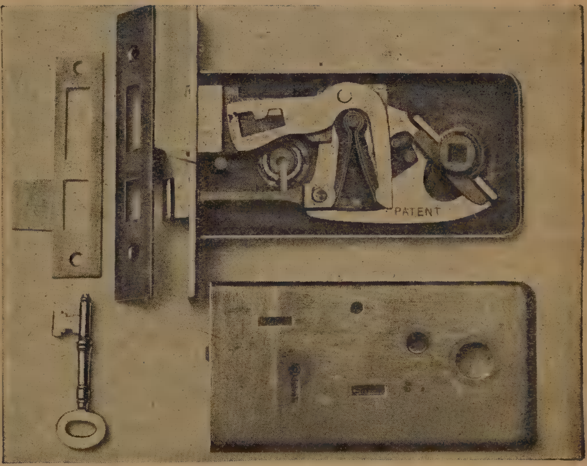


Fig. 1.—One-lever Mortise Lock with Reversible Bolt

very considerably weakening the door, and many forms of lock have been invented to overcome or lessen this trouble. Some locks are so narrow that they can be fixed in the space obtained by two or three centre-bit holes bored horizontally into the edge of the door. Others, again, are formed with a body quite round, and require but one hole to be bored for their reception. The former are known as centre-bit and the latter as tubular or barrel locks; but as the space for the interior parts is greatly restricted in these forms they lack much of the strength and security of the ordinary locks.

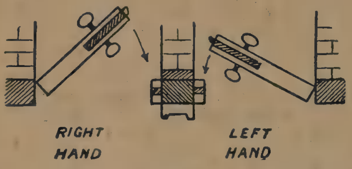


Fig. 2.—Diagram Showing "Handing" of Mortise Locks

The "Hand" of a Door Lock.—It is obvious that as a door may be hung to either the right or the left door post, some locks must be made for one "hand" and some for the other "hand," and this must be remembered when ordering. The ironmonger has one invariable rule for determining the hand, and that is by looking at the *outside* of a door and noting in which direction the bolt shoots; if to the right, then the lock is right hand. Doors usually open inwards, but occasionally are made to open out; in the latter case the ironmonger takes the hand in the same manner, but adds the term "reverse bevel," to denote that the bevel of spring or latch bolt is to face in the opposite direction to that for a door opening inwards. With mortise locks, however, a right-hand reverse bevel is the same as a left-hand ordinary, because the lock is symmetrical, or equal-sided. Rim locks have a reverse bevel, as distinct from a reverse hand. Fig. 2 shows the handing of mortise locks, and Fig. 3 that of rim locks.

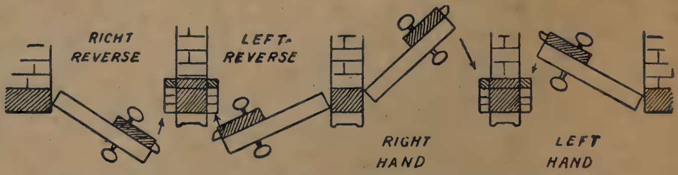


Fig. 3.—Diagram Showing "Handing" of Rim Locks

Fitting Mortise Locks.—Before fitting an ordinary mortise lock to a door, swing the door into the position that gives the best advantage from the available light, and secure the door at that angle by means of a wedge, as shown at A (Fig. 4). A 3-in. lock, suitable for lever handles, has been taken for illustration, and the height of the spindle has been assumed as 4 ft. from the floor. To set out the centres of the keyhole, spindle, and mortise, measure 4 ft. up from the floor on one face of the stile, square the point across it, over the edge, and across the other face of the stile. Then take the measurement between the centres of the keyhole and the spindle, and accurately transfer it to the stile, and square round as before, as shown by the lines B and C (Fig. 4).

When hanging a door, the usual practice is to shoot the closing stile a trifle under, so that when the door is shut it presents a closer joint than would be the case if the stile were shot square. The face of the lock is set square with the case; therefore an ordinary marking gauge is unsuitable for putting on the vertical centre lines of the keyhole and spindle. A gauge made as shown at D (Fig. 4), and applied to each face of the stile, with the shoulder kept tightly up to the centre of the edge of the stile, will produce the intersecting points E and F, the centres required.

The mortise is now set out by laying the lock on the face of the stile, and sighting the horizontal lines B and C through the centres of the key and spindle holes; tick off the width of the lock on the edge of the stile in its exact position, square these points across the edge, and run a gauge line down the centre of the edge of the door and the length of the mortise. On this line insert the centre of the bit when boring the mortise.

Bore the key and spindle holes halfway through from each side of the door; then bore the mortise by beginning at the bottom with a twist-bit of the exact size of the thickness of the lock. After boring the first hole, insert a hardwood pin of the same size as the bit, and the full depth of the lock. Bore the second hole parallel to this pin, withdraw the pin, and insert it in the second hole, and repeat this operation until the mortise is completely bored. Trim up the mortise with a paring chisel, and insert the lock in it; but before housing, as in Fig. 5, for the faceplate, see that the centres of the keyhole and spindle correspond with those already bored through the door. After housing for the faceplate, take it off, insert the lock into the mortise, and fix with screws, afterwards refixing the faceplate (see Fig. 7).

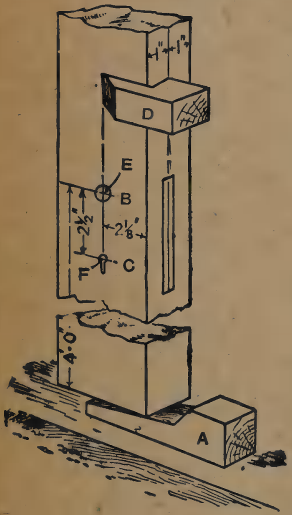


Fig. 4.—Setting Out Centres When Fitting Mortise Lock

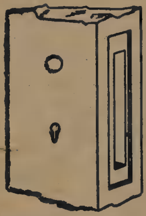


Fig. 5.—The Mortise and Housing

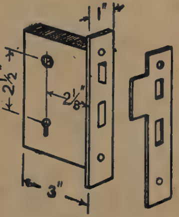


Fig. 6.—Lock and Striking Plate

To set out the mortises for the bolts shoot them, and close the door up to the jamb; tick off the tops and bottoms of the bolts on the jambs, square these points in off the stop with a set square, then take a little black off the oilstone, and touch the outer edges of the bolts with it. Close the door again, and shoot the bolts so as to make an impression on the door jamb, and mortise to these marks; then house for and screw on the striking plate (see Fig. 6) as shown at Fig. 8. The striking plate should be so fixed that the door, when closed, cannot rattle.

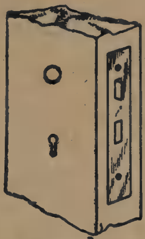


Fig. 7.—The Faceplate Refixed

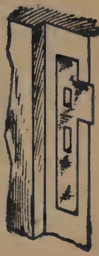


Fig. 8.—The Striking Plate Fixed

Fitting Barrel Mortise Locks.—The introduction of the barrel mortise lock has greatly simplified the labour of fitting, as compared with the old flat mortise lock, which often necessitates the use of a special swan-neck chisel for cutting the mortise on the end grain of the lock rail. The smaller barrel locks are made to fit a hole only 1 in. in diameter. Fig. 9 shows a typical example of a barrel lock; it will be noted that it has only one bolt, the key locking this and preventing the handle from being turned. Fig. 10 shows the brass catch plate.

In the fitting of a barrel lock, the door may easily be spoilt if the hole is bored carelessly. In a door the hole is made on the centre line of the rail, or midway between the tenons of the lock rail; but when fitting to an old door it may be necessary to dodge the keyholes, etc., of a former rim lock, which holes must be plugged temporarily or the new hole bored above or below them. Mark a vertical centre line on the edge of the door, and start a hole with a bradawl or small bit so as to give a fair start for the screw point of a twist-bit. Having first secured the door by wedging from the floor (if the door is already hung), start the bit very slowly and get an assistant to hold a try-square on the edge of the door (see Fig. 11), and to watch the bit and the square carefully to see that the bit is being inserted at right angles ; the assistant can also hold the straightedge against the side of the rail and stile so that the worker may glance down and check the direction sidewise (see Fig. 12). After the hole has been cut, the lock may fail to go right home, or it may appear to be out of square with the door ; and this may happen (however much care was taken in the boring) from a tendency of the bit to follow some irregularity in the end grain of the lock rail. In Fig. 13 the hole is shown to have "run" a little out of truth, and the method of getting it square again is to work the bit in again very slowly, with a gentle side pressure in the direction of the arrow, giving the nose of the bit a chance of cutting the untrue portion. Next, with a square mark the lines for the keyhole and spindle (see Fig. 11), and mark the dead length for boring them as measured from the outer flange of the lock, which should be let in flush with the edge of the stile. The position of the catch plate (Fig. 10) is readily found when the door is closed.

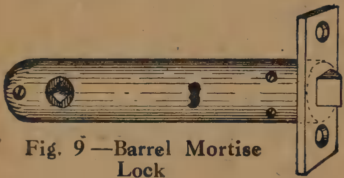


Fig. 9—Barrel Mortise Lock

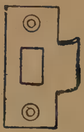


Fig 10.—Brass Catch Plate

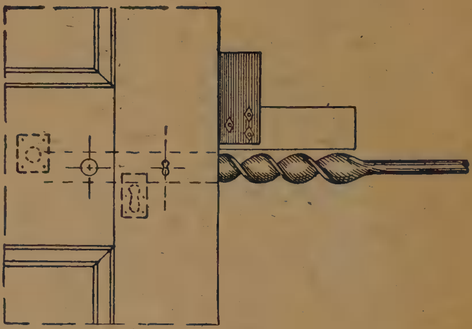


Fig. 11.—Boring for Lock at Right Angles to Door

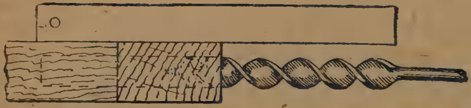


Fig. 12.—Using Straightedge to Check Accuracy of Boring

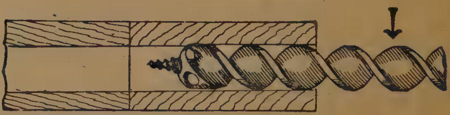


Fig. 13.—Method of Trying to Correct a "Run Hole"

Any space left by former keyholes and holes for spindles should be recessed around their vicinity and neatly patched as shown at Fig. 11. In the subsequent painting the work will require to be brought to a good surface, applying one coat of paint before filling in the cracks, and levelling with pumice ; but for full particulars of the treatment of woodwork when preparing for painting another chapter in this series of volumes must be consulted.

Rim Locks.—These are used very extensively for all classes of buildings, as they are so easy to fix ; but, on account of their unsightly appearance, they are relegated, in the better sort of houses, to the servants' quarters, kitchen offices, and sometimes the less important bedrooms. They are illustrated by Figs. 14 and 15. The old pattern, with wrought-iron case (Fig. 14), is still adopted for doors which are in frequent use, as it is stronger though more clumsy-looking than those with stamped steel cases, more or less ornamental in design. The latter are made double-handed by a special form of keyhole, which enables the key to be inserted the right way, no matter to which side of the door the lock is fixed. There is still another sort made with ornamental cast-iron cases, usually of a dead black finish.

The staples or receivers of all flanged rim locks are generally made with a flange also, and in fixing these the architrave must, of course, be cut to accommodate the length of the staple, this causing an ugly gap in the woodwork. This is obviated by the use of square staples, which are made without a flange, but if these are desired it is necessary to specify square staples, as otherwise flanged ones may be supplied. Brass bolts, which are now mostly fitted to all iron rim locks, are an improvement, as they do not corrode to any appreciable extent, and this ensures smooth working. For doors in exposed positions galvanising is a great protection, and does not cost much extra over the price of japanned locks. Conservatory doors are often fitted with brass rim locks, having phosphor-bronze springs, and for yachts and ships the use of brass instead of iron or steel, both in locks and keys, is most essential, owing to the corroding influence of sea air.

The portion of a rim lock most likely to give way under stress is the spring, and therefore in cases where strength is a consideration, locks fitted with Scotch springs, instead of the ordinary V-shaped feather-springs, are to be preferred. This Scotch spring is a long tapering piece of steel having its thick end riveted into the lock case, and its thin end bearing on an intermediate lever, which is pivoted to the latch bolt. Superior locks are sometimes fitted with what is called "palace motion," which consists essentially in the provision of a cranked lever connecting the spring to the bolt in such a manner that an easy action is obtained.

As in the case of mortise locks, there are several patented systems of universal handing in rim locks, some double and some "four-handed." Those of the mortise variety only require to be right or left, but with rim locks it is different, as they are occasionally required with a reverse bevelled bolt of either hand for doors opening out, as well as the regular pattern for doors opening in; this means four different styles, therefore the locks containing an arrangement to suit all these positions are termed "four-handed."

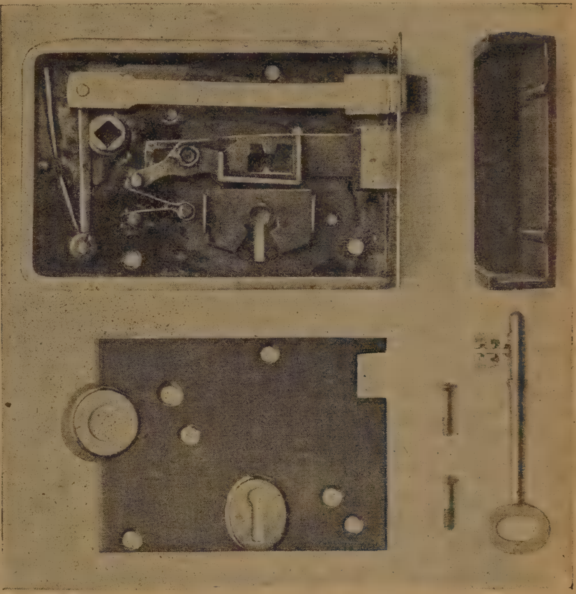


Fig. 14.—Warded Rim Lock with Wrought-iron Case

How to Fix a Rim Lock.—In fixing a rim lock it is first necessary to let the flange (the projecting lip of the faceplate) into the edge of the door. Next hold the lock in position, and mark through the keyhole and the spindle-hole with a bradawl on to the face of the door. The keyhole needs to be very carefully made. The shoulder, or stop, abuts against the lockplate, and keeps the key in its right position to enter and turn; but should the keyhole be too large, it does not guide the key exactly to the hole in the lock, and the key will strike the lockplate in a very annoying fashion. Bore the hole for the spindle exactly square with the face of the door; should the hole be out of truth, the worker will find on attempting to screw up the knobs, that they bind, and prevent the latch bolt from springing back freely when the knobs are turned.

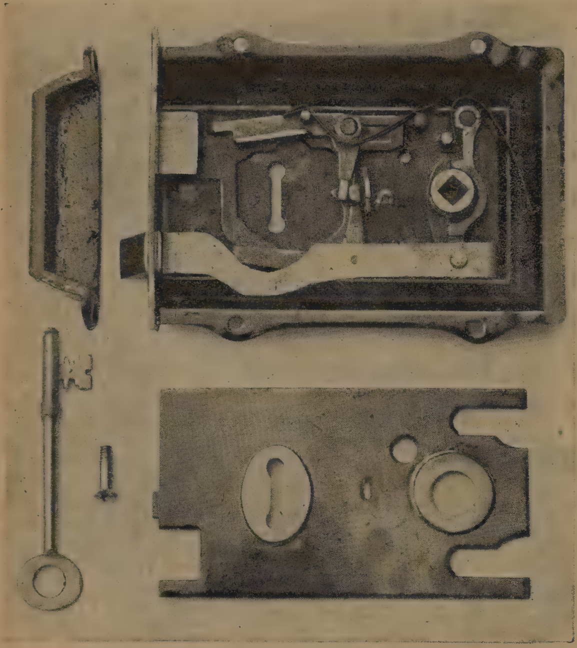


Fig. 15.—Reversible Rim Lock with Stamped Steel Case

The holes for the spindle and the key should be bored as nearly to the proper size as the bits can be obtained, and preferably a twist-bit should be used, care being taken not to force it to cut faster than it is made to do. A $\frac{3}{8}$-in. bit answers for an average keyhole, but as these bits are made to every sixteenth from $\frac{1}{4}$ in. to $\frac{3}{4}$ in., and every eighth beyond, and as they are useful for so many purposes, as many sizes as possible should be bought. It is essential to the proper entrance of the key and passage of the spindle that the holes for them be square to the face of the door, when a square is applied with the stock horizontal as well as vertical. A serviceable guide for the boring-bit is a turned piece of wood—say, 6 in. long—with a truly central hole from end to end, and a disc shouldered on. However, the keyhole will be true enough if the precaution is taken to hold the head of the stock at the same height as the point of the bit, and in the other direction as square as the workman can judge. When the bit ceases working, do not force it, but remove the chips if they should be filling the grooves of the bit, and examine the other side of the door to see if the point shows; when it does, the hole may be completed from that side. Another hole should be made for the bit of the key with a boring-bit of suitable size, and the two holes cut into one by a keyhole saw. Take care not to cut away too much, which a crooked saw will be almost sure to do; to avoid this risk cut once only in the middle of the wood between the holes, and complete the work with a thin chisel. The hole for the spindle can be bored with a $\frac{1}{2}$-in. bit, and if each hole has been made carefully, nothing remains but to screw the lock on and fix the box staple. Round-headed screws are mostly used for rim locks, and ordinary flat-headed screws for the coverplate. Put on the knobs and spindle, and the escutcheon, or keyhole plate; this plate is generally fixed with escutcheon pins.

The knobs and spindle, together with the escutcheons and finger-plates, are termed "lock furniture."

Cutting into the edge of the door frame may be needful in the fixing of the box staple; or, on the other hand, the staple may require mounting on a piece of wood. In either case, see that the bolt and latch of the lock have just enough freedom when the door is locked—say, about the thickness of a veneer or stout card. If there is a moulding round the door frame, the box staple must be let into it, fitting it very carefully.

Adding Greater Security to Door Locks.—The various petty burglaries that frequently occur in the neighbourhood of cities and large towns in the quiet hours of the afternoon and early evening demonstrate the weakness of locks and latches. Bolts and chains cannot be used at such times, and to put up shutters only creates suspicion and invites unwelcome attention.

A window well fastened and screwed is not generally the object of assault; but the front door readily yields to the jemmy or crowbar. The burglar does not have time to pick the lock or try his skeleton keys, but prefers to use his powerful lever to save time.

Examination of many doors that have been forced invariably shows the hasp (the box into which the lock is shot) to be bent out or broken, and will also demonstrate the weakness of draw latches and locks when they have been double-locked. To shoot the bolt farther into the hasp by double-locking does not necessarily ensure a stronger fastening. This is a result of the faulty make of these locks. Fig. 17 should make this clear. When the door is closed in the usual way, the door latch is in its strongest position, the projection of the bolt being then as far as the line A, but when it is double-locked the projection is as far as B, which, it will be seen, is nearer to the thin part of the bolt. If the door should be forced when in this position, the length of the piece projecting from the lock acts with greater leverage upon the weak part at B, and, providing the hasp is strong and well fixed, a bending or breaking at this point is inevitable.

To make a door more secure, a mortise lock should be fixed as far away from the ordinary night latch as convenient. The second lock will make the door doubly secure, and greater advantage is gained the farther apart the locks are fixed.

Another means of strengthening a door against attack is by screwing into the outer edge of the door a $\frac{1}{8}$-in. iron plate $1\frac{1}{2}$ in. wide, long enough to extend about 6 in. above the top lock and 6 in. below the bottom lock. This piece is made to take the mortise lock, so that it has considerable strength as an edge plate, and also it fills up the crevice so as to make it difficult for an instrument to be inserted. It is important to arrange the fixing of the locks so that their bolts shoot at the same instant and when the door is quite close. Fig. 18 shows the iron edge plate, which is filed and drilled ready for fixing. There is only one slot in this plate, because the night latch, of course, is fixed *on* the door, while only the mortise lock is in the door's thickness.

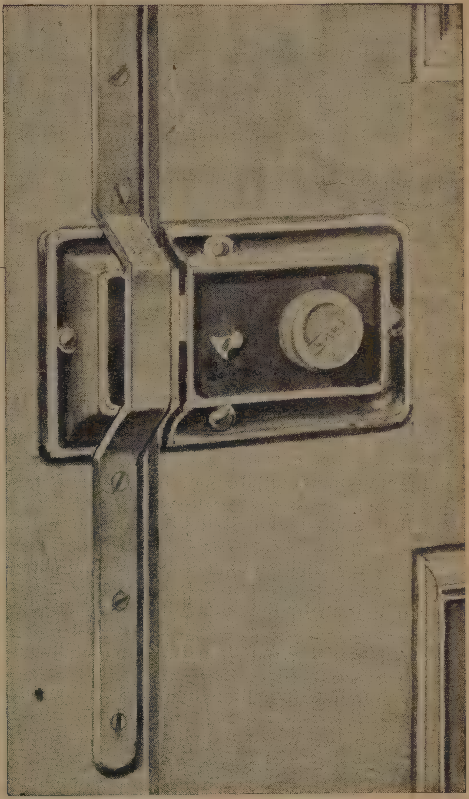


Fig. 16.—Lock Hasp or Box Strengthened with Iron Strap

The hasp of the top lock has a D-shaped piece of 1-in. by 4-in. iron screwed over it, as shown in Fig. 19. The perspective drawing (Fig. 16) shows the appearance of an iron strap used for strengthening a hasp.

In one instance, a door was strengthened by having a large draw-back lock as a second lock. An edge plate was used, and both hasps were secured by the double D-shaped plate, as in Fig. 20. This method is not quite so strong as that in which the bolt of the mortise lock is shot through the edge plate into the door-post.

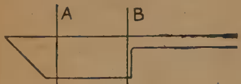


Fig. 17.—Part of Lock Bolt

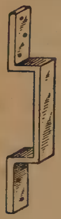


Fig. 19.—Iron Strap for Strengthening Hasp

Fig. 18.—Iron Plate for Edge of Door

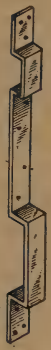
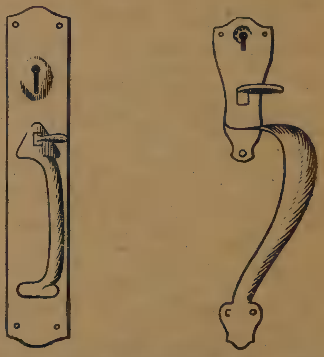


Fig. 20.—Iron Strap for Strengthening two Hasps

Upright Locks.—A form of lock used for schools, workmen's dwellings, and the like, is a combination of upright lock with thumb latch handle. This handle is of the usual "grip" shape, with a thumb bit by means of which the latch bolt is released, so that no furniture of the ordinary description is needed (see Figs. 21 and 22). These locks are nearly always provided with a heavy weight inside, which is pivoted to the latch bolt and keeps it projecting; but they are also supplied with spring action. When the thumb bit is depressed, its inner portion, which passes through an opening in the lock, raises the weight, causing the latch bolt to be withdrawn. A second bolt is actuated by the key when it is required to lock the door. It is advisable to specify the weight to be of brass, as if made of iron it is liable to rust and perhaps stick inside, or at least to work harshly. A small buffer of leather is often let into the underneath part of the weight so as to minimise the noise of its falling when the door is closed to. Mortise locks are also made on this principle; but then two handles are required, one for each side of the door.

Some Terms Explained.—It may be convenient here to refer to some of the terms used in the lock trade. A lock is said to be "bushed" when a small plate or ring of metal, usually brass or bronze, is attached to the cases in such a manner as to act as a bearing in which the follower or key-pin turns. It is well known that any metal object having a rotary movement meets with most friction when turning in a bearing of a like metal; therefore the followers are either made of malleable or soft iron, or of steel. The keyholes of rim locks are generally fitted with a bushing of an oval or rectangular shape surrounding the entire keyhole. This is called "full bushing." When only the portion which receives the key-pin is lined it is called "half-bushing," or "pin-bushing." Mortise locks are most frequently pin-bushed.



Figs. 21 and 22.—Upright Locks

There are several varieties of wards, but it will only be necessary here to describe some of the most usual sorts. Fine wards are those generally appearing in the common class of old-fashioned rim and mortise locks; solid wards denote a more durable class, for they are formed out of a solid brass casting turned in a lathe into a series of steps so as to fit the key accurately. Sash or collar wards are similar to solid wards, but instead of being fixed in the middle of the lock they are attached to the two sides or, technically speaking, to the case and cap. Keys corresponding to these three sorts of wards respectively are shown in Figs. 23 to 25. Lever keys are notched or stepped on the outer edge of the bit, but often have, in addition, collar wards, but when these are cut too deeply the key is much weakened.

Drawback Locks.—Drawback locks so called because the bolt is released from the staple by being drawn or pulled back by a knob, are used for hall doors. They are a survival of an older age, being so clumsy in appearance. They have one large spring bolt which, when it is necessary to secure the door at night, is locked out by means of the key; during the daytime this spring bolt is held back, if required, by what is known as a "back-slide" placed at the end of the lock, as clearly shown in Fig. 26. A good lever dead lock, either rim or mortise, would afford more security than the majority of drawback locks and be more sightly in appearance. The fitting is practically the same as in the case of the rim lock. If the door is such that it is unnecessary to lock it from the outside, as in the case of a house having two or more exits, it will lessen disfigurement by not having the keyhole cut through the woodwork; but, of course, one of the doors must be made so that the house, when vacant, can be locked from outside. The absence of an outside keyhole renders picking impossible. In one type of drawback lock the knob has a turn action.

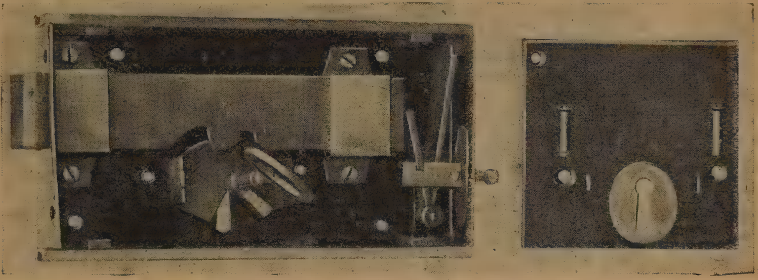
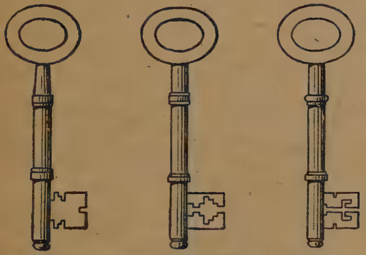


Fig. 26.—Drawback Lock with Spring Bolt



Figs. 23 to 25.—Keys for Fine-ward, Solid-ward, and Sash- or Collar-ward Locks

Dead Locks.—A dead lock is simply a rim lock with one bolt for locking purposes only (see Fig. 27), and is mostly used on doors which have to be locked most of the time, such as garden gates, wine cellars, stores, etc. Such locks are made in every quality, from common-warded up to six levers. For outside doors they should have galvanised cases, with brass bolts and interior fittings. They are fitted in the same way as an ordinary rim lock, except that no spindle hole is necessary.

Night Latches. — Hall doors are fitted with night latches, which, so that the keys may be convenient for carrying, are often made in very small form. Several excellent patterns are now on the market, notably those of the "pin-tumbler" type originally made by the Yale Manufacturing Company of America, and now manufactured also by several firms in England.

Night latches can be opened with a key only from the outside, there being a knob on the inside for pulling back the latch. The mechanism is fully shown by Figs. 28 to 30.

How to Fit an Ordinary Night Latch.—First measure accurately the distance from the edge of the lock to the centre of the key-pin, and mark this measurement on the inside of the door. Then bore for the keyhole, cutting for the bit of the key with a small mortise chisel as neatly as possible. Apply the latch and cut the flange, trying the key before fixing the lock. If the pin on which the key turns projects from the lock, cut in the flange first to the correct size, and then applying the lock and holding it parallel to the door, press firmly so as to imprint the position of the key-pin upon the door, thus indicating the centre of the keyhole.

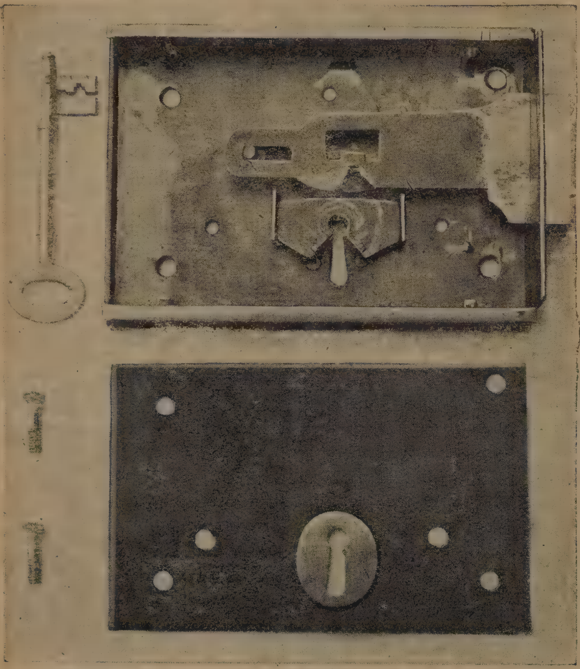


Fig. 27.—Warded Dead Lock with Plate Off

The Yale or Pin-tumbler Night Latch.—In this very convenient form of night latch the latch proper is much of the ordinary style, and is fixed on the inside of the door, but the part containing the mechanism actuated by the key is in the shape of a circular boss, and is on the outside. Both portions are connected together by two hidden steel screws, and a small flat brass bar conveys the motion from the key to the bolt. As it is not necessary for the key to pass through the entire thickness of the door, it is made quite short, and its shape is flat, with corrugations which tend to stiffen it, and also allow it to pass certain wards formed in the key slot. The Yale lock possesses considerable security against picking, but owing to the exposed surface of the most important portion of the case containing the vital parts, it is peculiarly susceptible to the attack of a drill in the hands of an expert, and no door should depend on a lock of this class alone.

It is realised that the Yale and similar pin-tumbler latches are generally regarded as mysterious mechanisms, and therefore some pains have been here taken to explain their construction. The parts of a Yale latch are shown by Fig. 31, in which figure A represents the cylinder part actuated by the key from outside the door; B is a ring which surrounds the cylinder and gives it an external finish; C is the connecting bar which passes through cap D to the actual latch E, which is of simple and quite obvious construction, and of which the plate is shown below it at F; G shows the key. There is only one part of the entire mechanism that has anything in the nature of a mystery about it, and that is the cylinder A, shown separately by Figs. 32 and 33. It consists of two cylinders, an internal one A, called by the makers the cylinder, and an external one B, which is here called a shell. In both cylinder and shell are pins, those in the shell C being pressed down upon by springs D and in turn pressing upon the pins E in the cylinder and slightly entering the slots of the latter; thus the cylinder is locked to the shell until the key is thrust into the narrow slot made for its reception, so lifting the pins until the outer ends of the pins E and the inner ends of the pins C are flush with the circumference of the cylinder; then the cylinder can be turned by the key quite freely, and the connecting bar F is caused to turn the latch. It will be understood that the pins E are of varying lengths, to suit the notches cut in the edge of the key.

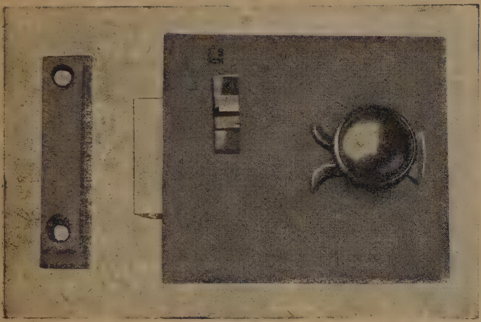


Fig. 28

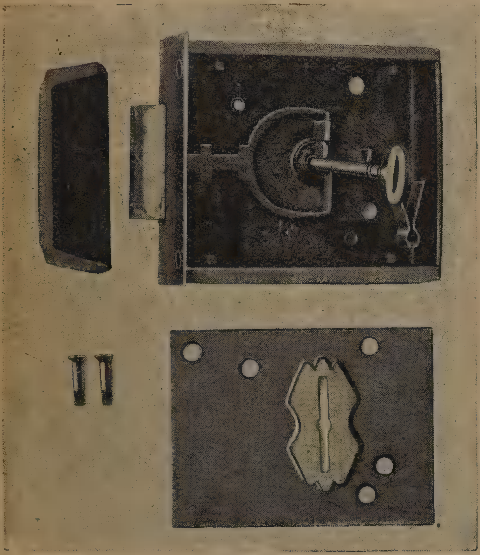


Fig. 29

Figs. 28 and 29.—Double-handed Warded Night Latch

Should the amateur attempt to take the cylinder to pieces, all that is necessary is to remove screw G that holds a so-called "cam" H; the cylinder can then be slid out in the direction shown by the arrow. The pins are sure to drop out, and their replacement may possibly give some trouble, for which reasons the makers issue with each latch a warning not to unscrew the cylinder. But the replacing of the pins is not so difficult once their function is properly understood. Assume that the cylinder A has been separated from the shell B and that the pins have fallen out of the cylinder. The trouble in replacing them is that they are of varying lengths, but if the key is inserted into its slot, and trial made, one hole at a time, until a pin is found whose top edge comes exactly flush with the outside of the cylinder (the key being in position all the time) the trouble is soon overcome. The replacing of the pins in the shell is, in one sense, an easier matter, seeing they are of the same length and are interchangeable; but it will be necessary to press in the springs with a thick lead pencil or a cylindrical piece of wood to facilitate the insertion of the cylinder. How to fit a key to a pin-tumbler lock is fully explained on a later page.

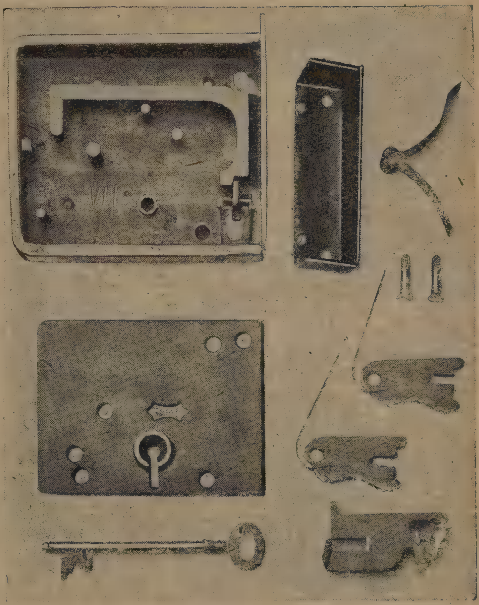


Fig. 30.—Parts of Night Latch (Lever Pattern)

Fitting a Pin-tumbler Latch.—For fitting a Yale latch, which, by the way, is adjustable to doors from ⅞ in. to 2½ in. thick, first bore a 1¼ in. hole through the door at the proper height, the centre of the hole being 2⅜ in. from the edge of the door. The connecting bar and long screws will need to be cut with a file or hack-saw to suit the thickness of the door. Fig. 34 shows the method of fixing, the letter references having the same meanings as those in Fig. 31. The ring B is slid over the rear of the cylinder A and the cylinder is inserted, keyhole down from the outside of the door; the cap D is placed in the proper position over the hole on the inside of the door and secured with tacks which pass through tiny holes in the lower part. Now insert the long screws H through the cap and into the

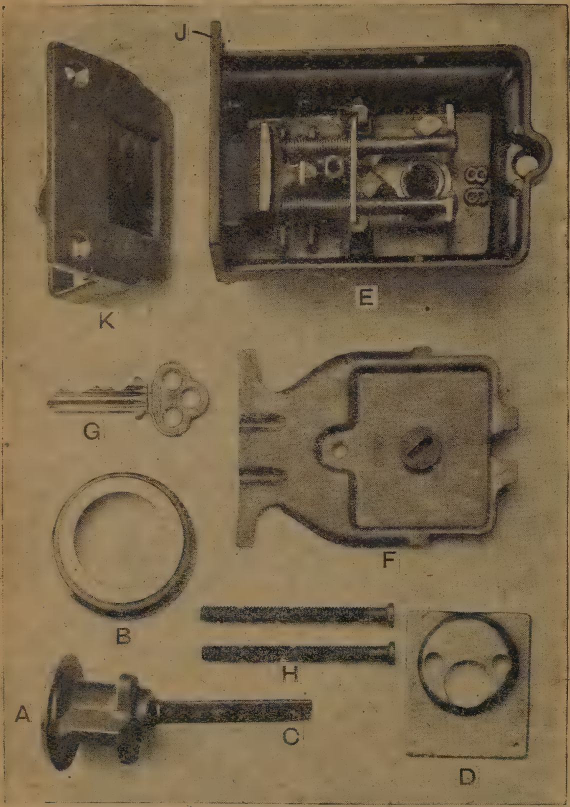


Fig. 31

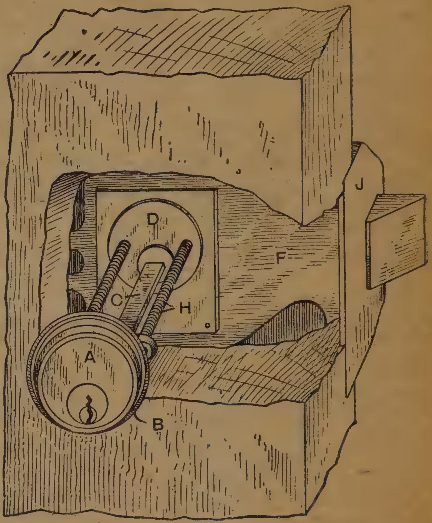


Fig. 34

Fig. 31.—Parts of Yale Pin-tumbler Latch

Figs. 32 and 33.—Rear Elevation and Vertical Section of Cylinder of Yale Latch

Fig. 34.—Fitting a Yale Latch

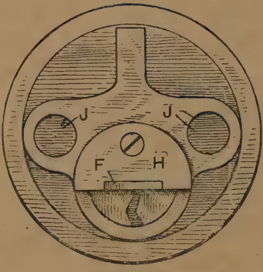


Fig. 32

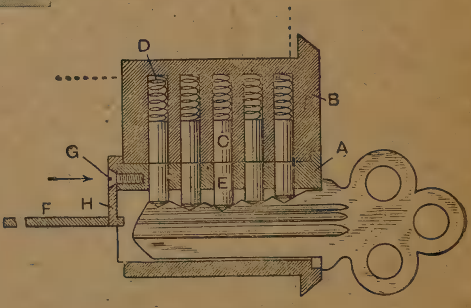


Fig. 33

holes J (Fig. 32), thus screwing the cylinder and the cap together. Place the latch case over the cap, and mark and cut the edge of the door to receive the lip J. Then attach the lock with screws in the ordinary way, and screw the combined box and striking-plate to the door jamb.

Plate or Stock Locks.—Plate locks, or locks fitted into a wood stock (hence sometimes called stock locks), are principally used for common purposes, and for rough doors in country districts, but a superior kind is made for church doors and the hall doors of old-fashioned mansions. The cases of these locks are made of birch, beech, or oak for the common classes, and of oak or mahogany, french-polished or varnished, for the better ones, these being often ornamented with iron or brass straps, corner plates, and escutcheons.

Rim Latches.—Rim latches (see Fig. 35) are used for doors which require to be kept closed only, not locked, such as large presses, closets, etc. When used for lavatories and bathroom in the cheaper class of houses there is a small bolt which enables the occupant to secure the door on the inside. These latches are fitted with a follower to take "furniture," and formerly this follower was always a smaller size than that in the ordinary two-bolted rim locks, hence they required a smaller size of spindle to fit. At present they are made to take either size, namely, $\frac{1}{4}$ in. or $\frac{5}{16}$ in., but it will be more satisfactory and more convenient to order these with $\frac{5}{16}$-in. follower, which is the standard size for rim and mortise locks, as by doing so any regular rim furniture can be used.

Cabinet Locks.—These include locks for cupboards, drawers, tills, boxes, sideboards, etc. The ordinary iron cupboard locks (see Fig. 36) are used for the doors of presses about a house, meat safes, hot closets, etc. If in a situation where they are liable to be attacked by damp, locks having a japanned case and brass bolts are best. They vary in size from 3 in. to 4 in., measured from top to bottom. For large linen presses, such as may be seen on the upper landings of some of the older houses, a larger sort, termed Scotch press locks, are perhaps more suitable. These measure about 5 in. across by 4 in. high. All of these are double-handed, as the bolt is designed to shoot both sides. For small locker doors or for the doors of cabinets or other furniture, brass locks (see Fig. 37) are more suitable, being narrower and having smaller and neater keys than the former. One fault, however, is the shortness of the bolt in the usual brass lock, which allows the door to be prised open without much difficulty. To overcome this objection locks with extra long shoots can be obtained.

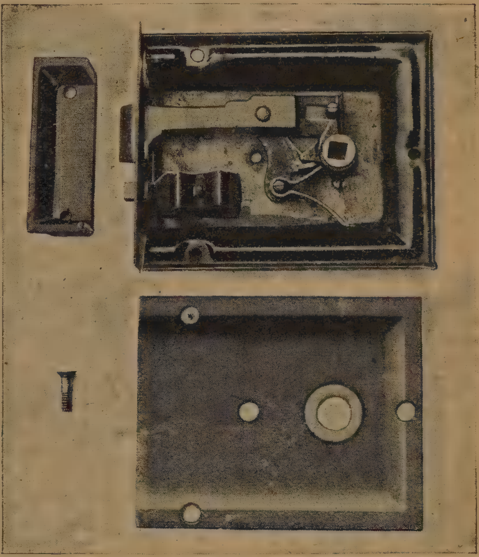


Fig. 35.—Rim Latch with Plate Off

All cabinet locks are made in both warded and lever qualities; but, in general, those made of iron are of the former type, whilst the majority of brass are lever locks. The keys vary also, some being of the solid pin class and others of the hollow or pipe description. The latter are far more secure, on account of there being less room for inserting picks in order to throw back the bolts.

"Straight cupboard locks" (Figs. 36 and 37) are screwed on to the inner surface of door stiles, and are double-handed. "Cut cupboard locks," which resemble drawer locks except that the bolt shoots horizontally, are sunk flush with the woodwork of the door, and are single-handed only.

Till or drawer locks (Fig. 38) are similar to the "cut cupboard" just mentioned, but have the keyhole at a right angle to the lock face instead of being parallel to it. They are sometimes made with a spring bolt that they may be self-locking, without the use of the key.

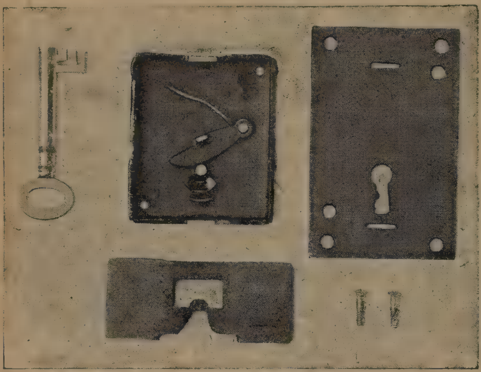


Fig. 36.—Iron Warded Cupboard Lock

Box or chest locks (Fig. 39) have a separate linkplate, which is intended to be screwed to the lid of the box. A sloping desk lock is really a box lock with its upper flange set at a right angle approximating to the slope of the desk lid. In some of these the linkplate is a loose fit for the lock, to allow for some expansion in the desk flap.

Fitting Straight Cupboard Locks.—These locks, as has been already said, are merely screwed flat on the inside of the door. The position of the keyhole is got by measurement, or, in the case of a projecting pin, by means of an impression, as described earlier in this chapter.

Fitting Cut Cupboard Locks.—The work of fitting a "cut" lock is practically the same as that of fitting a drawer lock, described in detail later; but the keyhole, if desired, may be bored from the inside, which generally would be awkward in the case of a drawer. The lock should be let in flush whenever possible, but sometimes the peculiar fixing of the striking plate prevents this, the backplate being let in. In fixing, first bore the keyhole, and get this and the keyhole of the lock exactly opposite, and see that the face of the lock is exactly flush with the edge of the door. Mark with a pencil round the body of the lock and the length of the faceplate, and let these in until the backplate lies on the back of the door (but not let in); then the key can be tried in the lock, and it must enter readily before the back plate has been finally let in: then if the key does not enter exactly, the lock can be shifted a trifle, but to do this after the lock has been let in disfigures the work.

Fitting Till or Drawer Locks.—First ascertain the centre of the drawer front and mark it lightly with a pencil. The length of the flanges of the lock should be measured carefully, and this distance marked off on the top edge of the drawer; then the lines are squared on the edge and down the inside (see A B C D, Fig. 40). Take care, of course, that the centre of the keyhole corresponds with the centre of the drawer already determined. With a marking gauge set to the breadth of the top flange, gauge the line A D; set the gauge exactly to the breadth of the wide flange, and make line B C. Set out the socket for the body of the lock as shown by E F G H, and with a fine saw cut along the lines E F and H G; these cuts must terminate at the lines E H and F G, and will therefore not be the depth of the

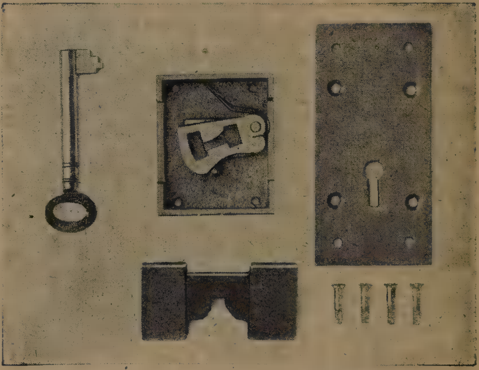


Fig. 37.—Brass Lever Cupboard Lock

lock at the bottom, but will need to be cut to the proper depth by means of mallet and chisel the waste between the lines being removed with the chisel. Next carefully remove the wood for the flanges of the lock within the lines A B C D the result being as shown in Fig. 41. If care has been taken, the lock will then be found to fit satisfactorily. The position of the keyhole must now be set out. The pin usually projects a little beyond the body, and if the lock is pressed into position the end of the pin will make a small indentation. Place the point of a very fine bradawl directly in the centre of this mark, and bore squarely through to the front of the drawer. With a twist-bit (its point placed in the hole made by the bradawl) bore right through from the front, and to prevent the bit splintering the wood inside, hold a piece of waste against it. With a slightly smaller bit, in a similar manner bore a hole where the bottom of the keyhole will come; and with a fine keyhole saw remove the wood between these holes or pare it away with a small chisel. The lock should now be placed in position and the key tried in; if it is satisfactory, the lock may be screwed on. An escutcheon may be let in flush on the outside. and it may be necessary to enlarge the keyhole somewhat to receive it. This kind of escutcheon must be pressed in sufficiently tight to hold, but at the same time not so tight as to force in the fibres of the surrounding wood. Thread escutcheons may be marked on the work by pressure or a slight tap with a hammer, which will

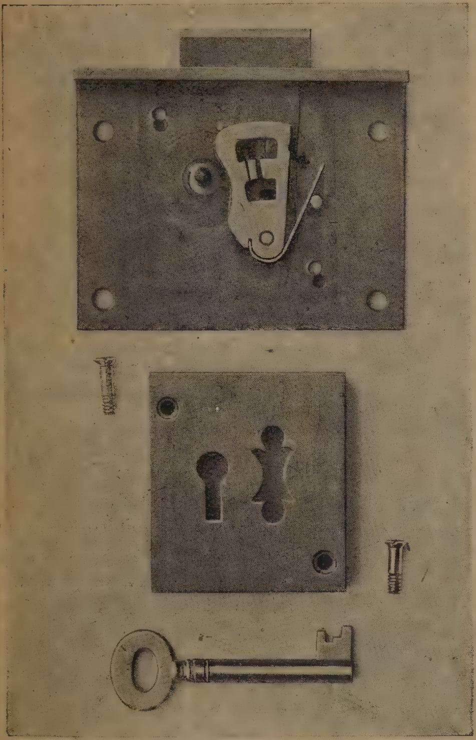


Fig. 38.—Till or Drawer Lock

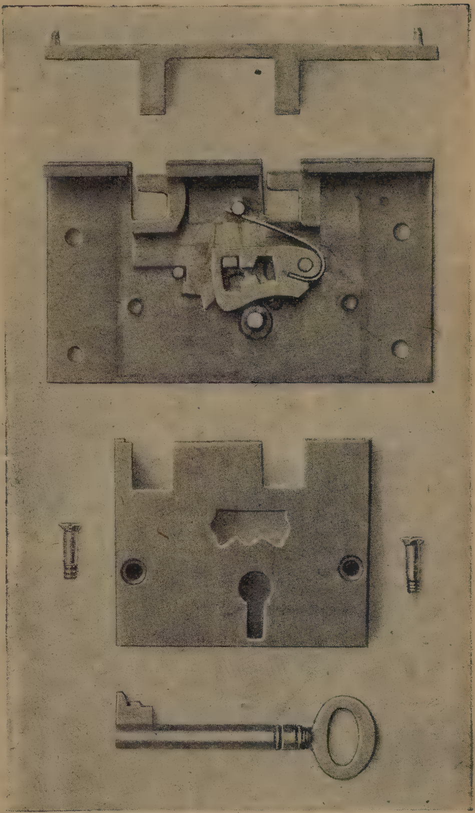


Fig. 39.—Box or Chest Lock

imprint an outline. To cut the bolt hole in the rail above the drawer, insert the key in the lock (when the drawer is open), turn up the bolt, and smear the end with some black material such as lampblack mixed with a drop of glue, or the soiled oil from the oilstone; then turn down the bolt, shut the drawer, and attempt several times to turn up the bolt so that it strikes against the rail above. After removing the drawer, almost the exact shape of the bolt will be found marked on the rail, and the space thus marked should be chiselled out (using, if desired, the special chisel shown by Fig. 42), so that the bolt does not strike against the top of the hole.

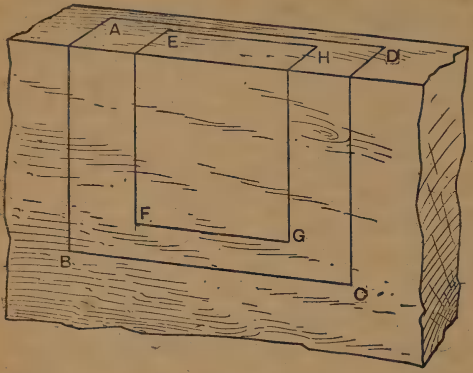


Fig. 40.—Fitting a Drawer Lock: The Work Set Out

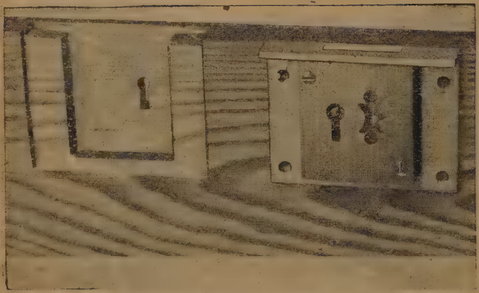


Fig. 41.—Fitting a Drawer Lock: The Recessing Finished

Fitting Box or Chest Locks.—These locks are fitted in practically the same way as a drawer lock. It is best to let the linkplate remain in the lock while the latter is cut in, or it may be found that though space sufficient for the lock has been made, there is no room for the links. The key must be tried before fixing the lock, in order to ensure room for the movement of the bolt. The smallest keyhole that will allow the key to pass is the best. For fitting the linkplate, which is provided with two small sharp pins on its upper face, first lock the linkplate in and slam down the lid of the box. Now unlock, and the two pins will hold the linkplate to the lid, and it will be an easy matter to mark round exactly where the plate is to be let in.

LOCK REPAIRING AND KEY CUTTING

The locks that come under the daily notice of the amateur mechanic are of the lever, latch, rim, tumbler and mortise types, and the padlock, but for reasons explained later the serious repair of a padlock is seldom possible. Lock repairing and key fitting necessitate the following tools: One 8-in. bastard-cut flat entering file for roughing the work into shape; one 6-in. second-cut flat safe edge for finishing; one 4-in. half-round file; about four or five warding files varying from the thinnest up to about $\frac{1}{8}$ in. thick, for cutting the wards and slots; also a pair of 3-in. callipers for taking off measurements; a small vice to cramp on the bench or kitchen table—one costing a few shillings will answer the purpose admirably.

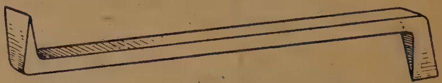


Fig. 42.—Drawer-lock Chisel

Four-lever Latch Lock.—The first job to be undertaken will be a four-lever latch lock, not because it is simplest, but because it will form the basis of all future operations. At the same time the functions of its pins, levers, and springs are an interesting lesson to the student of lock-smithing. This specimen of the craft will therefore be treated more exhaustively than any other.

Having removed the lock from its place

its coverplate (which previously rested against the door) will be found to be secured by two or three screws. Remove these, giving the plate a few smart raps with the handle of the screwdriver; then, grasping the tool at its other end, insert the point in the bottom of the keyhole with its edge towards the worker. Press the thumb as a lever against the bottom of the case, and this will be lifted from its seat, exposing the interior of the lock.

Four peculiarly shaped brass plates A (Figs. 43 and 44) will be seen lying one above the other. They are all the same size and shape, but their slots B differ, so that they do not coincide when in position, thereby necessitating corresponding slots and steps to be cut in the key.

These are the levers, held in position partly by a stout pin C, on which they work, and partly by a small spring D (see also Fig. 45) attached to each lever, pressing upwards against a second pin E. The reaction of these springs keeps the tailpieces P (Fig. 44) of the levers down in close contact with a small lug F (Fig. 43). This lug is fixed to, and carried backwards by the follower G between the slots in the levers, after they have been raised by the key into their proper positions to receive it. Meanwhile the follower will have taken with it the bar that draws back the latch H, thus completing the action.

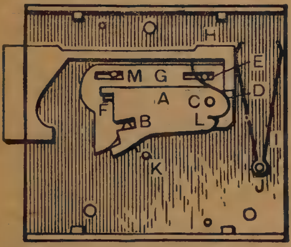


Fig. 43.—Mechanism of Lever Latch

The foregoing describes the movements in their normal condition, and to seek the cause of any breakdown, and to apply an effectual remedy, proceed as follows: Take the top lever between the thumb and finger, disengage its spring and lift it out; do likewise with the remaining three levers, taking particular care to mark each one as it leaves the lock, for they must be put back in their relative positions The follower G (Fig. 43) (see also Fig. 46) travels freely from side to side with a small stud M and pins E and C (Fig. 43), from which the levers and springs have just been removed, acting as guides between its slots. Take this out and remove the V-shaped featherspring I from the pin J. Lastly, unscrew the brass knob and take out the latch, leaving the case empty.

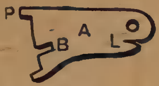


Fig. 44.—Lever

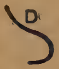


Fig. 45.—Lever Spring

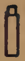


Fig. 47.—Key Pin

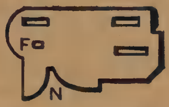


Fig. 46.—Follower

In the course of this dissection the fault will have been located. The four pins C, E, J, and K, and the four lever springs and the featherspring, are the weak spots, and their repairs will now be considered.

Renewing Broken Pin.—To renew a broken pin, file off the riveted head on the backplate, and punch the old piece out; or, if the riveting has been countersunk flush, it can be chipped out with the point of a chisel or a drill run through. Take a piece of wire or rod, as the case may be, of the requisite gauge (a stout french nail or the shank of a wood screw answers the purpose very well), cut it off $\frac{3}{16}$ in. longer than the finished pin is to be, and grip it firmly in the vice, allowing just the $\frac{3}{16}$ in. to stand above its jaws. Then take the file, and, keeping its safe edge down on the vice, reduce the substance of the pin evenly all round until it nicely fits the hole in the plate (see Fig. 47). Turn the lock face downwards on to the pin, and rivet the shoulder well over on the outside, taking care to leave the pin perpendicular to the plate. A lug or stud may be treated in the same way.

Renewing Broken Spring.—If a lever spring is broken, grip the lever in the vice and slightly open the saw-cut L (Fig. 44) by tapping the point of a screwdriver into it, allowing the broken end of the spring to fall out. Procure a piece of spring steel of the same substance and length (or a hacksaw blade may be softened and split up), taking care not to have it any wider than the thickness of the lever, and should it require bending at the end, soften it by heating to a light heat and allow to cool. Then bend it to the shape of Fig. 45, re-harden by heating as before and at once plunging into cold water. Again take the lever and close the saw-cut L previously opened by resting one of its edges on the vice and tapping the other to such an extent that the edge of the spring will not enter without some amount of force. Lay the lever on some solid surface with the saw-cut towards the left hand, which should now bring the spring over the entire length of the fissure, when a few taps with the hammer will drive it down into its place level with the face of the lever, where it is securely held by the grip of the opposing surfaces.

If the featherspring has "given out," a new one may be bought for a penny. The extreme ends should be softened and bent in towards each other as shown in Fig. 43.

Wipe all parts with a rag moistened with paraffin, and apply a little oil to their faces and pins. Then replace in their original order, screw on the coverplate, and the lock is complete.

It may be mentioned that the various makes of locks have slightly different shaped levers and disposal of springs; but as essentially the same principle underlies them, the foregoing is sufficient for general guidance.

Instead of the key-pin K, sometimes the key itself forms the pin, a hole being drilled in the backplate to receive it. Further reference will be made to this later in the chapter.

Cutting a Key for a Lever Lock.—It is necessary to know the construction of the lock to understand what is required of the key—namely, first to raise the levers so that their slots all coincide at a point level with the lug on the follower, and then to throw the follower back.

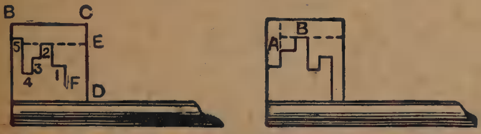
Take off the coverplate, remove the levers, and put them carefully aside. Then, taking the lock to an ironmonger's, purchase a suitable blank (Fig. 48), having previously noted the thickness of the door to which the lock is to be fitted. In selecting a key-blank, care should be taken that it fits the pin properly—neither loosely nor tight. It should butt well down on to the backplate. It will be too long from A to B to enter the keyhole and too wide from B to C to turn in the lock, even if it did so enter. Lastly, see that it is sufficiently long in the shank D to pass through the door and allow room for the bow to be turned on the outside. The same remarks apply to a blank of the pin type.

Grip the shank of the key-blank in the vice, blank to the left hand, bow to the right, with the edge B C upwards, and with the bastard file reduce it sufficiently to pass through the keyhole. Then try it in the lock, and if it nearly enters the notch N (Fig. 46) on the bottom of the follower, take the finer file and trim it down until it does. It should then carry the follower well back. Next take the master lever (this will at once be recognised by its slot being nearer its bottom edge than that of any of the others); supposing it to be the one marked No. 2, put it down on the follower, temporarily taking the place of No. 4. Then file the edge of the blank down until it lifts this lever into the position indicated above. Do not take the cut the whole distance from B to C this time, but leave the part marked 5 in Fig. 48 exactly as wide as the follower is thick. The dotted line E shows the work at this stage.

Next take out lever No. 2 and replace it by lever No. 4. Then, using a warding file a little thinner than the lever, cut slot 4 (Fig. 48) down at the side of 5, trimming and fitting downwards or sidewise, as occasion may require, until a cleft has been worked sufficiently deep and wide to allow the lever to drop into the required position. Round off the top edges as proceeding. Now replace lever No. 3, and proceed as before. It may be necessary to cut a deeper cleft still or a step higher, according to the position of the slot in the particular lever. Replace lever No. 2; and here it is obvious that the key requires no touching, as, being the master lever, it was given first attention. Put lever No. 1 into place, cut the remaining portion of the blank down to suit that, until the key in this state of progress operates the whole concern. Then screw on the coverplate, and take off the portion of the blank that projects above it (F, Fig. 48) until it turns. Finish with emery-cloth, touch with oil, and a well-fitting key should be the result.

If after the blank has been cut down to pass the keyhole it should require much further reduction to enter the follower, beware of the master lever, for although the first member is generally the longest, this is not always so. In this case only cut a notch A (Fig. 49) a shade wider than the follower is thick until it has the desired effect. Then find the master lever, place it down on the follower as before, cut the whole edge down to suit it (B), and follow on step by step as already explained.

It is rarely that this kind of key admits of any refitting to other locks, but with the experience already gained the worker can easily judge for himself.



Figs. 48 and 49.—Cutting Key for Lever Latch

To cut a key to pattern, callipers are used, as shown in Figs. 50 and 51, carefully setting them to the measurements of the original and then cutting the duplicate to them.

It may be added that many of these cuts can be made with a hack-saw, but its skilful use needs experience.

Cutting Key for Warded Lock.—When a new key is required for a warded (not a lever) lock, it is not always necessary to get a blank and cut the wards. It is the custom for ironmongers to keep a large stock of keys with the wards ready cut, and a key can generally be found that will fit the lock with a little alteration. As these are the same price as blanks there is nothing gained by obtaining a blank if a key can be got instead.

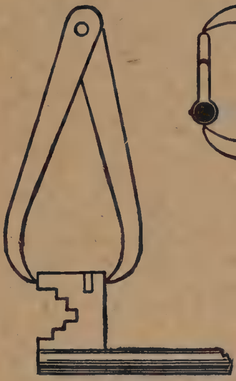


Fig. 50

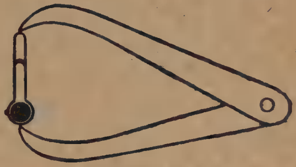


Fig. 51

Figs. 50 and 51.—Cutting a Duplicate Key

The common form of latchkey shown in Fig. 50 can often be bought for the same price as the blank alone would cost.

Should it be required to fit a key to a locked door, the size of the blank required must be ascertained by measuring. By holding it in the flame of a candle it may be smoked black; then it is inserted carefully into the lock, and by turning as to unlock it an impression is made to show where metal has to be filed to clear a ward. It may be necessary to repeat this several times, and care must be exercised not to file away too much metal.

A waxed key gives even better results than a smoked one, the wax (beeswax, or even stiff tallow) being as thick as the size of the keyhole will allow. The internal conditions of the lock will be more faithfully shown in the wax than in the smoke.

Repairing the Mortise Lock.—The mortise lock (Fig. 52) is so called on account of its being mortised into the door, rendering it invisible on both sides. Take out the small screw in the neck of one handle and pull it off, and draw the other handle through from the other side, bringing with it the spindle. At the edge of the door will be seen two screws. Remove these, and a faceplate can be taken off, revealing two more screws. Remove these, and by prising first the top and then the bottom the lock can be drawn out.

It will be noticed that the outside of this lock is most carefully finished, with countersunk screws and collet F sunk in flush. These provisions are to facilitate the introduction into and withdrawal from the mortise. Take off the coverplate and the latch A, bolt B with lug C, tumbler D with spring E, spindle collet F with bar G, featherspring H, and wardplate I will be seen. There are also four pins. Any repairs may be executed in the same manner as already described for the latch lock.

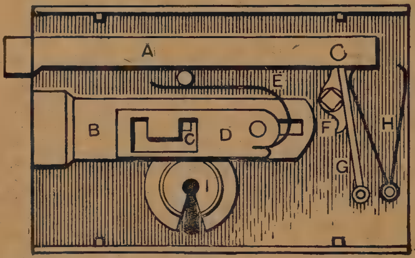


Fig. 52.—Mechanism of Warded Tumbler Mortise Lock

The key required for this lock is shown by Fig. 53, the part B throwing the bolt back, while C lifts the tumbler, which is analogous to the lever in the latch. If not possessed of anything that lends itself to alteration, a suitable key can often be obtained at a marine store dealer's, and a few strokes of the file will make the necessary clearance where required. Note particularly that there is sufficient length from A to B to throw the bolt well backwards and forwards, for if the key leaves the bolt half-way it is useless, and locks are often blamed for this fault in the key.

If the lock does not possess a wardplate, but has wards on the back- and coverplates, a key as shown by Fig. 54 will be required, the steps being cut as already described.

Cutting Key for Yale Pin-Tumbler Latch.—The duplication of a pin-tumbler lock key (see Figs. 31 to 34, p. 12) is not difficult; some makers of these locks supply suitable blanks, and it is then a simple matter to file notches to agree with those in the key that is already in existence. Let it be assumed, though, that there is no key from which to copy the notches; in this case it is better not to attempt to cut the key to correspond with the existing pins, but to notch the key-blank in a reasonable way, thrust it into the cylinder, and insert pins very slightly too long for their holes, and then file them flush with the circumference of the cylinder. But, by laying the pins of the old cylinder in a row, and with their top edges in line, their respective lengths can be gauged, and there would be no particular difficulty in cutting a new key to correspond, care being taken, though, not to cut the notches too deeply, as it is easy to file pins that are too long flush with the cylinder but impossible to make good any metal that has been cut out of the key. The shape of the notches should not be too abrupt.

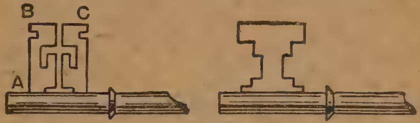
The above is assuming that it has been possible to separate the cylinder from the shell; but this presupposes the existence of a key from which a new one could have been copied straight away, without going to the trouble of taking the mechanism apart. The making of a key for a pin-tumbler latch when the mechanism cannot be got at is a problem which may give the amateur much trouble. One way out of the difficulty is to cut down with hack-saw, as indicated by the two dotted lines in Fig. 33 (p. 12), thus removing the top of the shell and releasing the springs and pins, afterwards brazing or screwing on the cut-off portion; or the part could be wholly filed away, and a strip of metal afterwards fastened on. A better way is to drill down into the little chambers that hold the springs and pins; and a very fair idea as to their positions may be gleaned from Fig. 33 (p. 12), which is exactly full-size. It will not be difficult to plug the holes afterwards with tightly-fitting pieces of brass, and finally make all good by brazing, if thought necessary.

It must be remembered that grooves milled on each of the flat sides of the key give it a cross-sectional shape that corresponds with that of the slot in the cylinder G (Fig. 31, p. 12); therefore, in fitting a new key, it is necessary first to obtain a blank that will fit the slot.

Padlocks.—With regard to padlocks, it is obvious that, from their exposed positions, they must not include any parts that are easily accessible. The cases are therefore riveted together, and no repairs are possible, for once the case is forced open it cannot be made good again. It is a wise plan to cut a duplicate key and stow it away in case of accident. The very best of these locks are stamped with an identification number, together with the name of the maker, who will supply another key to fit. Keys to padlocks must be fitted by examining the wards, as far as possible, through the keyhole, or by blacking the blank as previously described. Warded padlocks, however, can easily be picked by holding the lock on one side and raising the tumbler with a pick, when the bolt will drop back by its own weight.

Padlocks are made in all sorts and sizes, from the tiny dog-collar size to that used for warehouse doors. Some have a short length of chain attached for securing the bars of iron gates. Some are made self-locking; and others again are made from which the key cannot be withdrawn unless the lock is fastened. For lock-up stores and warehouses it is advisable to use a lock the bow or shackle of which fills the hole in the staple neatly, leaving no room for the insertion of a crowbar wherewith to force the lock apart. There is a right and a wrong way in clasping a padlock on its hasp and staple. The correct way when the staple is horizontal is to hook the shackle in from the top side downwards, for when it is inserted from the under-side the lock can be so held by anyone who wants to open it that by pushing in a bit of wire so as to raise the tumbler, and then shaking the lock a little, the bolt falls back by gravity, a thing which is impossible in the former case. Of course, this mainly applies to tumbler and common lever locks, but it is as well to take no risks even with the better grades.

Improving a Common Lock.—The action of the usual lever or fixed-ward lock is that the key revolves on a pin, and in doing so it forces all the levers back, or the cut in the key must clear the fixed wards. At the same time the key shoots the bolt forward by pressing into the notch of the latter. Fig. 55 shows a lever lock of a common type, and Fig. 56 the key. A simple way of treating this lock to prevent its being opened by a key of a similar pattern is to cut off a small portion of the pipe or front of the key (see Fig. 57). The portion cut off is fixed to the pin of the lock as shown. Fig. 55 shows the portion—by dotted lines—ready to be fitted in position; it can be fixed by wedging with a thin piece of iron. The same method could be adopted for a desk lock, or for a drawer lock, or on any lock where the key works on a pin.



Figs. 53 and 54.—Cutting Keys for Warded Mortise Locks

Worn Keyholes in Lockplates.—Many locks are bushed at the keyhole with a small extra plate to take wear, but occasionally a lock will be found without a bush, and the keyhole so worn that the key is loose in the lock. Fig. 58 shows at A the covering plate of a lock with worn keyhole. If it is only slightly worn, the metal may be stretched by means of marks with a centre punch, as shown at B, but the keyhole of the lock-case cannot be done in this way without removing the bridge ward, which is rather a troublesome job. The best way to bush a lock is to cut out a small brass plate with keyhole, and solder or rivet it over the worn keyhole. An easier method is to employ an iron washer as used for putting under the heads and nuts of bolts. Get it of a size to fit over the pin of the key. File one face of the washer bright; now scrape or file the keyhole of the lock bright, and lay the washer on it with the bright part downwards. Apply some "killed spirit" (zinc chloride; hydrochloric acid "killed" by immersing in it some scraps of pure zinc) to the washer and keyhole, place a small piece of solder between them, and next hold them in the flame of the gas or over a clear fire until the solder melts; then lay the plate on one side to cool. The job will now appear as shown at C, and after the part marked A is filed away the repair is completed. The collar of the key will probably require filing back to allow for the extra thickness of the bush.

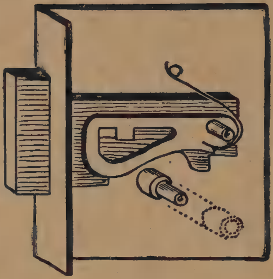


Fig. 55.—Lock with Part of Key on the Pin

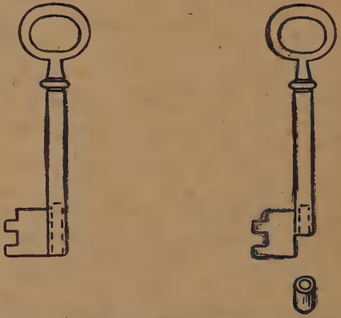
Remedying Broken Bolt.—In small locks, such as used in desks, the bolt is sometimes broken. This cannot be repaired, as any extra thickness at the place where it is broken would prevent the bolt from working, but it is comparatively easy to make a new one. The broken pieces should be filed bright on one side, and laid on a piece of brass of the same thickness, and soldered on as described in bushing a lock. Now file away the brass plate round the old bolt, hold it in the gas to melt off the old pieces, and the new bolt will be complete.

Stuffed-up Keys.—A key barrel sometimes gets partly stuffed up and requires picking out before it will unlock a door; yet even this little matter is often not properly understood. Now, a key barrel gets stuffed up very gradually, as a rule, and the dust gets compressed hard and tight. The picking out is thought to be such a very small matter that a pin is the implement usually employed to do it, but it is better to take a bradawl and probe it vigorously.

Keyhole covers (Fig. 59) are useful for keeping dust and damp out of locks. For outside yard or garden-doors, the ordinary iron japanned locks soon rust and get out of repair, unless kept well painted. The galvanised iron wood-covered locks are the best, preferably oak; and even then they should have a bevelled weather board over them to keep the rain from getting in behind.

LOCK PICKS AND FALSE KEYS

Some years ago the possession of a skeleton key would cause a person to fall under a certain amount of suspicion, yet now such keys are openly sold by many traders. These keys have no wards, or, rather, they have a gap where the wards should be. So commonly made were the majority of front-door locks until recently that it is not too much to say that, with a few skeleton keys, most of the locks in a street of middle-class or cheap-class houses could be opened quite easily. The only way to prevent this is to use lever locks of good quality which differ from each other. Let it be assumed that A (Fig. 60) is the



Figs. 56 and 57.—Altering Key of Common Lever Lock key of a heavy warded lock, such as that shown by Fig. 14, p. 5. A skeleton key of the shape shown at B (Fig. 60) will open the lock as easily as would the original key. The keys of a tumbler lock rarely, if ever, have wards in the lock corresponding to more than one or two cuts in the key. Skeleton keys are made in a variety of patterns, and will pass almost any warded lock; even in cases where they will not do so, a pick would do the work. Three picks are shown in Fig. 61. To open the lock of which the key is shown by Fig. 62, the skeleton being shown by Fig. 63, it would be necessary to use two picks like the first of those in Fig. 61, one to raise the tumbler and another to throw back the bolt.

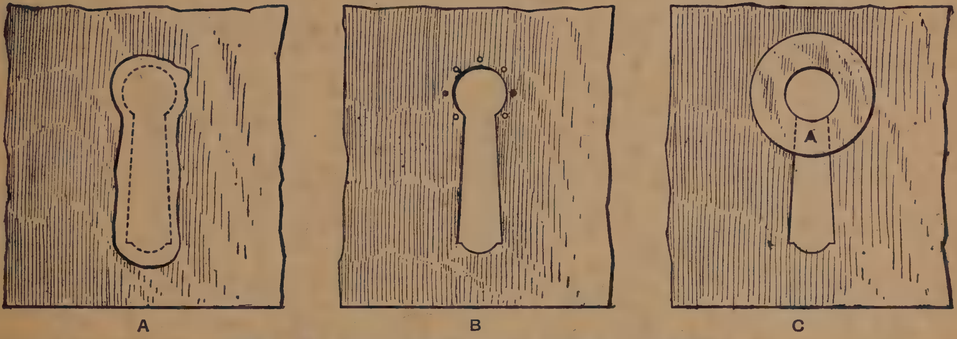


Fig. 58.—Repairing Worn Keyhole in Lockplate

Skeleton keys are useless with the lever lock; there are no wards in locks of this kind except for arranging suites of locks with master-keys. Each additional lever adds to the security, and some of the best makes of locks have as many as fifteen. In unlocking the lock, each lever has to be raised to a different height, and it follows that only the proper key will open it. That such locks are generally secure against opening with false keys may be judged from the fact that a seven-lever lock is capable of over four thousand changes; or, in other words, it might be necessary to try that number of keys before one would be found capable of opening it.

The lever lock, however, is not unpickable. Fig. 64 shows one description of instrument used for the purpose. A is a solid rod with one step, used for engaging with the bolt, and B is a tube fitting over A, having a step for raising the levers. The weight at the end of A causes the bolt stump to be pressed against the face of the levers, and then by raising each lever in turn with the tubular key B, the position of the passage or gating in the lever is ascertained by the difference in the friction when pressed by the stump, and when in position and no longer pressed by the stump. As each lever is raised the weight C is carried along the lever arm D, so as to keep the levers in position by the extra pressure, and when all the levers are raised the bolt slides back. Should the lock have a pin, as is probably the case, the pin must be knocked out and a hole drilled in the plate to receive the key, or two very thin tubular keys may be used, when it will be unnecessary to remove the pin. A section of the instrument when in action is presented by Fig. 65. Picking a lever lock is, however, a very tedious operation, and can only be accomplished by a skilled locksmith, with plenty of time to spare, so that for general purposes ordinary lever locks afford ample security.

A very ingenious arrangement is adopted by leading makers for detecting the use of picks or false keys. Should only one of the levers be overlifted by the pick, a detector is thrown into action and a small catch engages with the main bolt, rendering it immovable, and thus defeating the intention of the operator. When the owner of the legitimate key tries to open the lock he finds his key will not act until he turns it round the reverse way, as if locking. This takes the detecting mechanism off the bolt and enables him to open the lock; he is thereby notified that the lock has been tampered with. In such locks a "curtain" is also provided. This is a simple disc of brass inside the keyhole, which revolves with the use of a key or a pick, and in the latter case prevents the insertion of a second pick to operate on other levers. This detector and curtain are applicable to almost any description of lock, whether for room doors, drawers, boxes, etc.

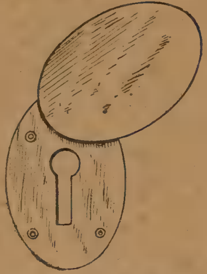


Fig. 59.—Keyhole Cover

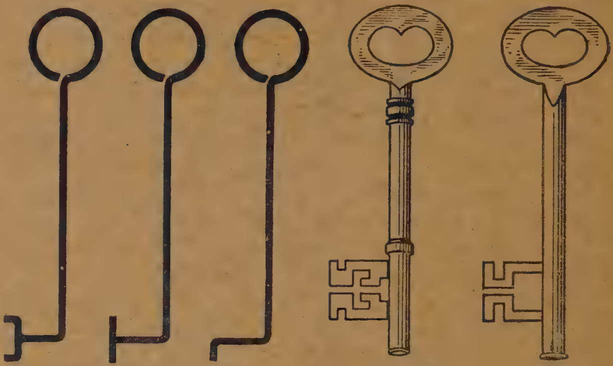


Fig. 61 Fig. 62 Fig. 63

Figs. 61 to 63.—Picks, Key, and Skeleton Key

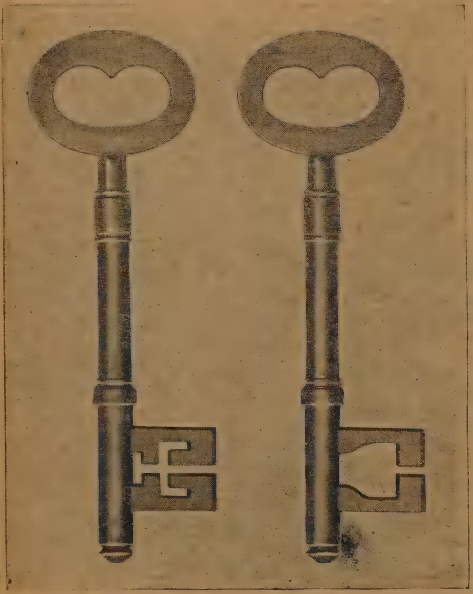


Fig. 60.—Ordinary Key and Corresponding Skeleton Key

If the key of a hall door or of any important lock, such as a till or desk in which valuables may be kept, is lost or mislaid, and fears are entertained that it may get into undesirable hands, the locksmith should be instructed when making the new key to put an alteration in the levers, which may easily be done by simply rearranging them, so that the old key, if surreptitiously used, may not work

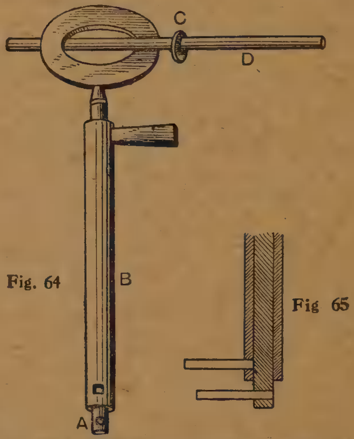
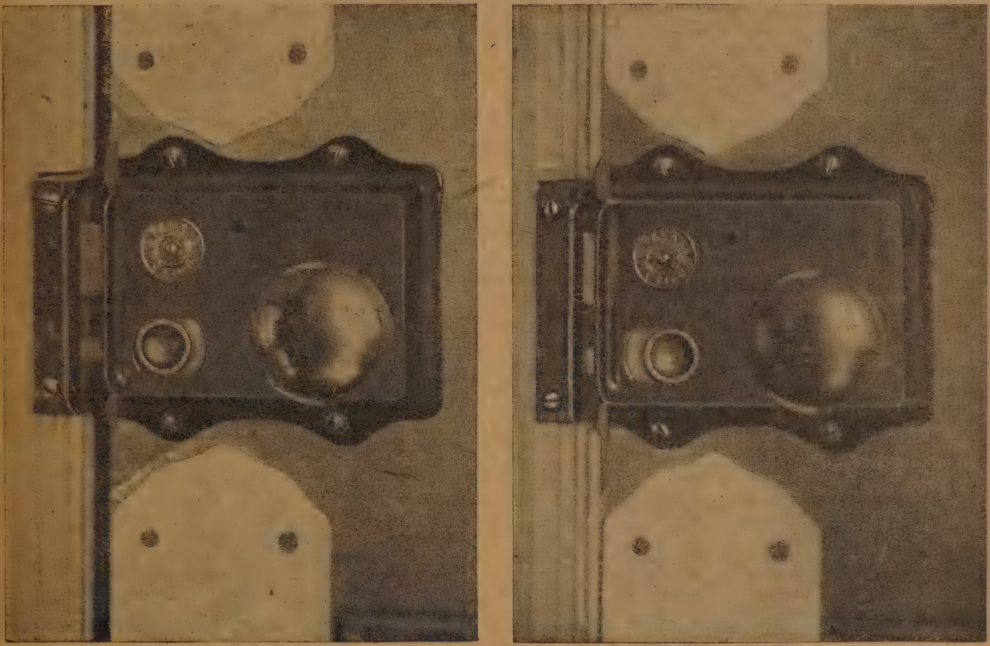


Fig. 64 Fig 65

Figs. 64 and 65.—Device in Picking a Lever Lock

ADJUSTMENTS FOR SHRUNKEN DOORS, ETC.

Many of the troubles connected with locks arise not from disordered or broken mechanism, but from faulty fitting or from shrinkage of the woodwork to which they are attached. Fig. 66 shows a typical trouble. The photograph shows part of a door fitted with a rim lock, and there is so much space between door and framework that the bolts scarcely catch in the box (see Fig. 68); indeed, during the dry summer months they do not catch at all. The remedy for this is to partly withdraw the two screws in the box-catch, pack up with a bit of wood behind, and then to tighten up the screws; but sometimes it is necessary to take out the screws altogether and plug up the holes with wood before replacing. This door was also treated with rubber draught-proofing. It is here shown finished by Figs. 67 and 69.


Figs. 66 and 67.—Shrunken Door and How to Remedy It

A more correct way of treating a shrunken door is to take it down, joint a slip of wood on the hinged edge, re-fit, and hang; but this is seldom done unless it is intended to re-paint.

A properly fitted door should be as Fig. 70 shows, and if the wood is dry and well painted it is likely to keep so; but if the top and bottom edges are left bare it will absorb damp, and the door become too tight.

The latch shown in Fig. 66 is usual for bedrooms, etc., where it is only desired to fasten occasionally on the inside, which is done by the small slip-bolt below the latch-bolt. The finger-catch for shooting the slip-bolt can be seen in the illustration.

Fig. 71 shows a common rim lock, which is lock and latch combined, and is most suitable for doors which open from outside, yards, etc.; it can be locked from the inside or outside. It has the same complaint as the latch shown by Fig. 66, and careless fitting may cause it to have one other. In putting on a lock it is just as well to have it straight and the catch uniform with it, for appearance's sake; but it is more important that it should be put on in such a way that when the door is shut it is kept shut *close*. The one shown rattles a great deal, and allows a bad draught. The cause is shown in Fig. 72; at A will be seen $\frac{1}{8}$ in. of space between the door and the rebate of the doorpost, and the diagram also shows $\frac{1}{4}$ in. space at the edge of the door. There is also $\frac{1}{16}$ in. between the latch-bolt and the inner side of the box-catch (see B). To put this right, the lock is first taken off and the screw-holes plugged up; then it is put on straight, and a shade higher and nearer to the box-catch; but not so much as to have to alter the keyhole or handle. The box-catch is then taken off and sunk $\frac{3}{16}$ in., besides being lowered a shade and wedged at the back to send it forward, as was done with the one shown in Fig. 69. Draught-proofing also is put on.

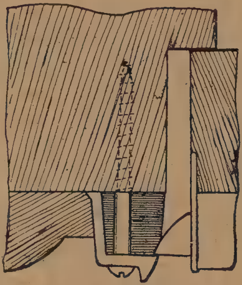


Fig. 68.—Shrunken Door

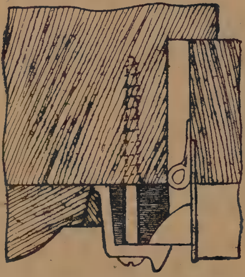


Fig. 69.—Shrunken Door Remedied

In fitting any lock very neatly with the catch, it is a good plan to file the sharp square edge of the latch-bolt to a slight bevel so as to enable it to get into the catch more readily (see C, Fig. 73), and the extreme sharp corners of the lock-bolt may be filed off for the same reason. This also assists in keeping the door close.

For the doors of best rooms, a better-class lock, the "mortise lock," is usual. Should shrinkage occur in a door fitted with a mortise lock (see Fig. 74) it is best to joint a piece on the back edge and re-hinge. The commonest trouble with the mortise lock is that should the door happen to droop $\frac{1}{8}$ in., the bolts will not then enter the slots in the plate-catch. It might only need the screws of the hinges tightening, or it may be necessary to back out the lower hinge by loosening the screws and slipping a bit of cardboard behind; or the top hinge could be sunk a little, unless it is quite close. In some cases it is best to take the door down, plug up the screw-holes, and hinge it a little higher. Another way is to observe where the bolts come against the plate; the plate may then be taken off and filed, or replaced in a position to correspond with the lock, but as this means altering the holes in the wood, the former methods are preferable. When the trouble is very slight, a little filing of the corners of the bolts will often be sufficient.

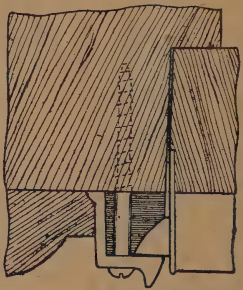


Fig. 70.—Door Properly Fitted

At times (particularly with the mortise lock) it will be impossible to unlock the door, owing to the bolt hole not being quite deep enough, and the door having swollen a little causes the end of the bolt to press hard against the back of the hole. In this condition, the key cannot easily unlock it, and force might break it. A wedge-shaped tool should be inserted between the lock and catch to force them a little more apart, then the key should be turned first to lock the bolt fully, and afterwards it will unlock with ease. The hole should then be deepened to avoid further trouble.

HOW TO MAKE A LETTER LOCK

A letter lock is a lock whose bolt is surrounded by a number of rings having notches through which a set of studs on the bolt must pass before the lock can be opened. The notches are so arranged as to prevent the passage of the bolt except when certain letters on a series of exterior rings are brought into line with each other so as to form a particular word or combination on which the lock was set. It is generally a padlock, in which form it was either invented or developed about the middle of the seventeenth century.

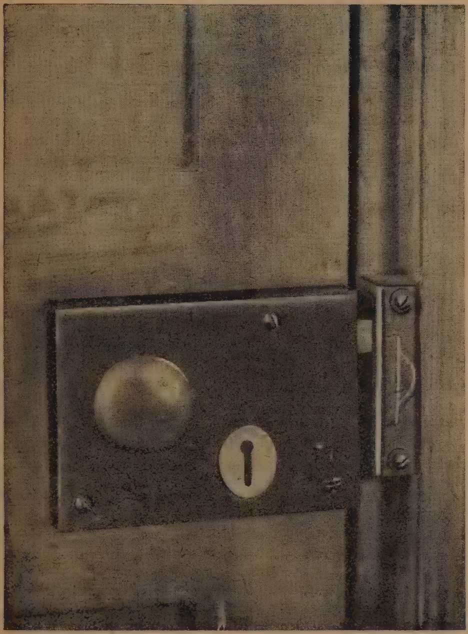


Fig. 71.—Badly fitting Common Rim Lock

The mechanical amateur capable of doing accurate work would take pleasure in making and using such a lock as that shown by Fig. 75 (p. 29). It has a central lettered portion T D E, two side parts L W and B K, and a movable bow hinged to one of the side pieces at L S G. The side F B K is of iron, shaped as shown at Fig. 76. It measures exactly 1 in. from A to B (Fig. 76), and $\frac{1}{3}$ in. from C to D. The widest portion, from E to F, measures $\frac{5}{8}$ in., while the neck is almost straight from C to K for a distance of nearly $\frac{1}{4}$ in. Figs. 77 and 78 give other views of the sides F B K and L G W (Fig. 75). The lower part X K (Fig. 75) is $\frac{1}{8}$ in. thick, while the upper part is $\frac{1}{5}$ in. thick over all, and S A (Fig. 78) is $\frac{9}{32}$ in. Drill the hole A (Fig. 77) right through, and tap it $\frac{1}{6}$ in. Its centre is $\frac{3}{10}$ in. from the bottom. Now file away the metal between F R N (Fig. 77), the breadth of the cutting from F to R (Fig. 77) being $\frac{1}{4}$ in., the thickness of each of the sides $\frac{1}{24}$ in., and the depth $\frac{1}{20}$ in. The next step is to bore the hole V (Fig. 77); in this hole lies the catch N (Fig. 75) when the padlock is locked, and it must therefore be bored to a depth of $\frac{1}{6}$ in.; its diameter is $\frac{5}{32}$ in., and the upper portion of its circumference is $\frac{1}{10}$ in. from the top.

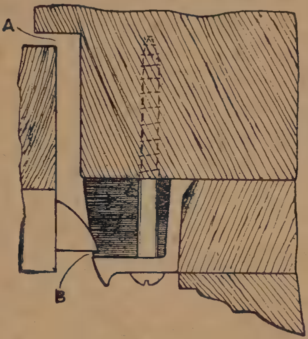


Fig. 72.—Badly-fitting Door

Now mark the guide-line K (Fig. 75), which is used as an indicator when opening or closing the padlock. To do this, find a point R (Fig. 76) along the middle line A B, so that A R measures $\frac{3}{4}$ in. Then draw R F at right angles to A B to give the required point F. Fig. 78 gives a view of the surface G (Fig. 75). The hinge side L G W (Fig. 75) very closely resembles the side just described; in fact, the two sides are of the same size and shape, excepting that the hole W (Fig. 78) occupies the same position as the hole A (Fig. 77), but is made a little larger, and is only $\frac{1}{10}$ in. deep; S G (Fig. 75) measures $\frac{7}{32}$ in.; and the depth at A (Fig. 78) is $\frac{1}{20}$ in. and at S $\frac{1}{10}$ in., and similarly for the opposite side, thus making the surface A S and opposite side tapering and sloping down from A to S.

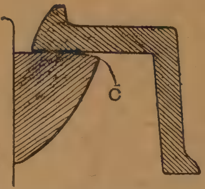


Fig. 73.—Latch-bolt Filed to Enter Catch

The slit Z (Fig. 75), in which the hinge of the bow works, is cut through the metal as shown at Z E (Fig. 78) and Fig. 75. It should be $\frac{7}{24}$ in. long by $\frac{1}{10}$ in. wide. Drill a small hole through the metal at K (Fig. 78) for the pin on which the hinge of the bow works, and mark the position of the guide-line W (Fig. 75) in the same manner as for K. This completes the description of the hinge side.

The internal mechanism is very simple. One of the chief parts is the toothed pin (Fig. 79), consisting of an iron cylinder $1\frac{9}{16}$ in. long by $\frac{1}{6}$ in. diameter, with seven small iron teeth. It is screwed for a distance of $\frac{1}{8}$ in. to fit tight in the hole A (Fig. 77) when the padlock is put together. A piece is cut out at S (Figs. 79 and 81), so that W T measures $\frac{7}{24}$ in. (see Fig. 81). The teeth are in the same straight line, and are $\frac{1}{12}$ in. high by $\frac{1}{32}$ in. broad, and $\frac{1}{16}$ in. long. The first tooth is $\frac{1}{8}$ in. from the screw end, the second $\frac{1}{3}$ in., the third $\frac{17}{32}$ in., and the fourth $\frac{3}{4}$ in., from the end. The remaining teeth are $\frac{31}{32}$ in., $1\frac{5}{24}$ in., and $1\frac{7}{16}$ in. respectively from the same end. The teeth and the body of the pin may be filed from one piece of iron; or, if preferred, the teeth can be cut separately, and then firmly inserted. A sheath for this pin (see Fig. 80) is a cylinder of iron or brass about $\frac{1}{64}$ in. thick, by $1\frac{9}{20}$ in. long, with a slit $\frac{1}{10}$ in. in width. The internal diameter should be a little over $\frac{1}{6}$ in., or just wide enough to allow the cylindrical portion of the pin to move quite freely in it. Mark the point R (Fig. 80) so that R W is $\frac{5}{8}$ in., and drill a very small hole directly under R, so that its centre is $\frac{1}{8}$ in. from the upper margin R. Now place the end M in the hole W (Fig. 78) for a depth of $\frac{1}{10}$ in., with the slit central, and solder it in the position as shown in Fig. 82, where Q represents the end of the toothed pin inserted in its sheath. The hole W (Fig. 78) should be filled up with solder, so as to hold the sheath as firmly as possible. The toothed pin is held in position by a small iron peg firmly inserted in the hole X (Fig. 82), as shown in plan at V (Fig. 81). This peg must not touch the pin, which now has only a limited motion backwards and forwards of about $\frac{1}{12}$ in. This allows the padlock to open and close, for it is obvious that this motion, small as it is, is just sufficient to free the side J B K (Fig. 75)

Fig. 74.—Door Fitted with Mortise Lock

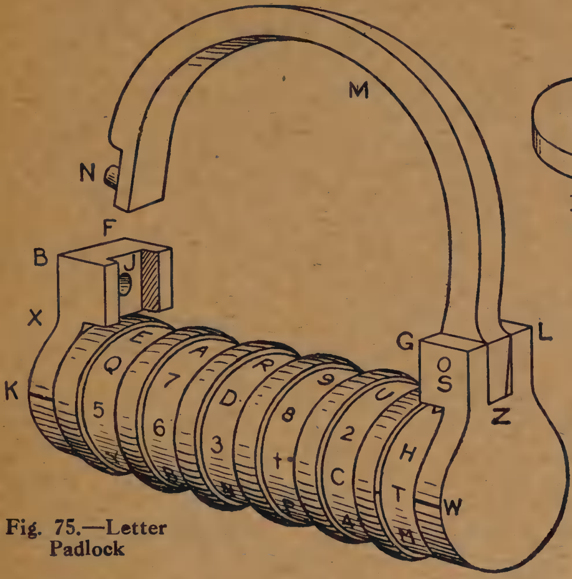


Fig. 75.—Letter Padlock

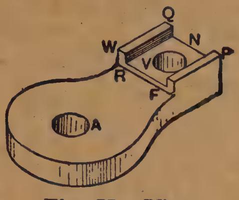


Fig. 77.—View of Screw Side

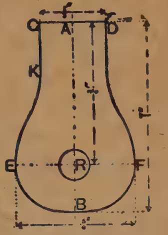


Fig. 76.—Outline of Screw Side

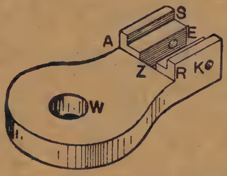


Fig. 78.—Hinged Side, Ready for Insertion of Toothed Pin

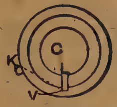


Fig. 83.—End View of Toothed Ring

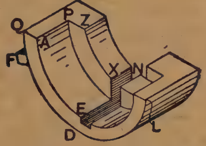


Fig. 85.—Toothed Ring Cut to Show Interior

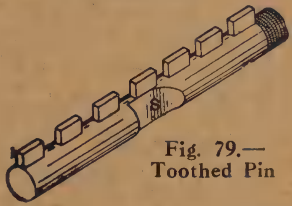


Fig. 79.—Toothed Pin

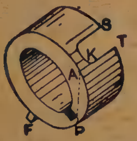


Fig. 84.—Special Toothed Ring

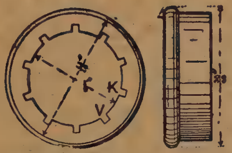


Fig. 86.—Lettered Ring with Milled Edge and Channelled Face

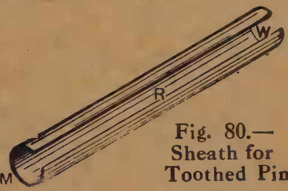


Fig. 80.—Sheath for Toothed Pin

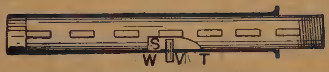


Fig. 81.—Plan of Toothed Pin in Sheath

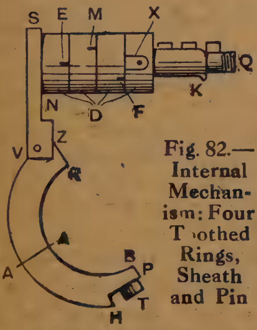


Fig. 82.—Internal Mechanism: Four Toothed Rings, Sheath and Pin

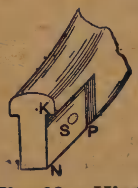


Fig. 88.—Hinge of Bow

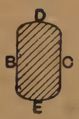


Fig. 87.—Section Through Thinnest Part of Bow

from the catch N (Fig. 75). File off the head of the iron peg until it is almost flush with the outside of the sheath. It is possible to use a small screw instead.

Fig. 83 is an end view of one of the six toothed rings, and Fig. 85 represents one of these rings, enlarged, cut in half to show the interior plainly, D N in Fig. 85 corresponding to the slit L in Fig. 83. Each of these rings must be $\frac{34}{64}$ in. diameter by $\frac{7}{32}$ in. wide. The internal diameters, $\frac{1}{4}$ in. From P to Z measures $\frac{1}{16}$ in. (Fig. 85), and from A to P almost $\frac{1}{8}$ in., while A Q is $\frac{1}{24}$ in. Now file a narrow slit $\frac{1}{12}$ in. deep in each ring, as at D N (Fig. 85), and attach a small tooth of iron, as F (Fig. 84). The depth ($\frac{1}{12}$ in.) is measured from the point X (Fig. 85), and not from the point E.

To find the position of the teeth, proceed as follows: From V (Fig. 83) mark the ring at K, so that K V measures $\frac{1}{6}$ in. This indicates the position of the upper side of the tooth K. A hole is then drilled a little below this point, and a pin is inserted. These pins are rectangular in shape, and measure $\frac{1}{32}$ in. in height and $\frac{1}{32}$ in. in breadth, by $\frac{1}{16}$ in. long.

The opening at T (Fig. 84) is cut in one ring only, in the following manner: Mark off a point A (Fig. 84), so that P A measures $\frac{3}{10}$ in., and draw the line A T parallel to the axis. Then cut through the ring so that K T measures $\frac{1}{6}$ in., while S T is $\frac{1}{8}$ in. wide. The object of this opening, shown at X (Fig. 82), is to allow of easy access to the iron peg or screw in the pin's sheath. Pass the end K Q (Fig. 82) through each and all of the rings, so that they lie similarly to those shown at D. The rings must be placed so that the edge Q D L (Fig. 85 is nearest the hinge side S V (Fig. 82). The teeth, therefore, lie as shown at E M F (Fig. 82). The sheath K (Fig. 82) should fit the hole C (Fig. 83), so that the rings move freely around it without undue slackness. The end of the sheath is slightly hammered at K (Fig. 82) until it is flattened out all round, so that it is impossible to remove the rings or pull them apart in the slightest degree. If this is not done properly, it will be impossible to lock the padlock. The inner edge of the ring should be slightly filed all round so as to form a sort of bed for the head of the sheath. The pin Q (Fig. 82) can now only be drawn out $\frac{1}{12}$ in. when the toothed rings are arranged with their channels in line with the teeth on the pin.

The next step will be to cut six lettered rings of brass, V U 9 R A E (Fig. 75), which are the means by which the internal mechanism is worked. Each ring is shown in front and side elevation at Fig. 86, and has ten narrow channels or grooves running along its whole length. The rim is milled, and is $\frac{1}{12}$ in. wide, the depth of each ring being $\frac{1}{4}$ in. The ten channels are made just large enough to allow free passage of the teeth E M F (Fig. 82). Pass the rings over D (Fig. 82), so that the rim is nearest the screw side F B K (Fig. 75). Screw on the side F B K (Fig. 75) as shown until the end Q (Fig. 82) is just flush with the outside of F B K (Fig. 75). This side is meant to screw off and on, so as to enable the word by which the padlock is opened and locked to be changed, if necessary. Now see that the rings move round the sheath (Fig. 82) quite freely, but of course carrying the rings D (Fig. 82) with them.

Having removed the side F B K (Fig. 75), turn each of the lettered rings round until all the slots in the toothed rings are in the same line with the teeth on the pin, to allow the pin to be pulled out as far as possible. Then mark on the side of the lettered rings any letters, figures, or signs, as T C + 3 6 5 (Fig. 75), taking care that they are in line with the guide-lines W K. It is now obvious that every time these letters, etc., are brought into this position the pin can be drawn out $\frac{1}{12}$ in., and will therefore open or lock the padlock.

Now find another row of letters by removing all the lettered rings from D (Fig. 82), and replacing them again so that each channel is placed over a different tooth from that on which it was before. Thus, if in forming the line T C, etc., the channel V (Fig. 86) were placed over the tooth E (Fig. 82), place the channel E over this tooth, and so with the other rings. Then, proceeding exactly as before, place opposite the lines W K (Fig. 75) a row of letters and figures when the lettered rings are arranged so that the side F B K (Fig. 75) can be pulled outwards about $\frac{1}{12}$ in. Proceed in this way until the ten channels have been placed, one at a time, on each tooth, when ten rows of letters will be produced, three of which are shown in Fig. 75. Place these letters so that they appear upside down when the rim side of the ring is held towards the left hand. Take care that the same letter does not occur twice in the same ring, though it may occur twice in the same row.

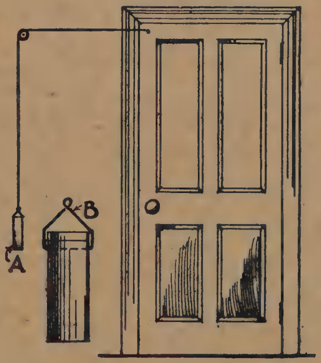
The iron hinged bow M (Fig. 75) is shown complete in Figs. 75 and 82, while Fig. 87 shows an enlarged section at A A (Fig. 82). The sides B and C are flat and parallel. The two ends R B (Fig. 82) are made a little larger than the centre A (Fig. 82), which measures $\frac{7}{32}$ in. from B to C (Fig. 87), by $\frac{1}{4}$ in. from D to E. Fig. 88 shows how the bow is cut for the hinge. Here P N measures $\frac{7}{32}$ in., M N $\frac{1}{10}$ in., and K N $\frac{5}{24}$ in. The hole S is drilled so that it is opposite the hole K (Fig. 78) when the parts are together; these holes should be slightly countersunk. An iron peg is passed through, and its ends are hammered to secure the bow. The length from Z to T (Fig. 82) should be $1\frac{3}{8}$ in., while from H to P must measure $\frac{1}{4}$ in., so as to fit against the side at J (Fig. 75).

To change the word by which the padlock is opened, unscrew the side F B K (Fig. 75), and take off all lettered rings. Replace these, and in so doing take care that each tooth is placed in a different channel from that in which it rested before. This, of course, will give a different combination along the line W K (Fig. 75) when the lettered rings are arranged so that the side F B K (Fig. 75) can be pulled outwards $\frac{1}{12}$ in. It is necessary to emphasise that the success of the lock as a piece of mechanism depends entirely on strict adherence to the foregoing instructions, and to the employment of very careful workmanship.

A Self-closing Door

In a case in which it is desirable for a door to close automatically, a hard-wearing cord may be attached to the top of the door, taken horizontally along to, say, an adjoining corner, over a small wheel or pulley-block, or even simply through a screw-eye, and attached to a weight, as at A in the illustration herewith. This, when properly adjusted, will be found to pull the door quietly into position. The same simple device could be adopted in a reversed form in order to keep a door open, and in cases where sufficient height is available, the weight could be arranged to work between the head of the door and the ceiling, in order to be out of ordinary reach.

The weight itself may be a small sash-weight, or, instead, a small circular tin filled with shot or scrap lead; two holes are bored, and a stout wire loop fixed as at B, the lid being then fastened permanently in position by means of solder, etc.



Paperhanging

WALLPAPER in sheets was introduced into Great Britain by William of Orange, and an attempt was made at its manufacture. About a hundred years afterwards sheets gave place to rolls, on which the pattern was stencilled. To-day wallpaper is decorated by many different methods—machine-printed, hand-printed, by a combination of the two processes, and hand-painted, as in the case of marble patterns. Quality is distinguished by the ground rather than the printing. In the commonest variety—pulps—the natural colour of the material forms either ground or ornament.

Machine Papers, as the name implies, are machine-printed, and comprise nearly nine-tenths of the papers used.

Sanitaries are printed in oil colours or washable distemper, so that the pattern will not rub up or soil.

Grounds are papers in plain tints.

Gold Papers have parts printed with an adhesive, on which the gilding follows. In a cheaper variety bronze is substituted for gold.

Satins possess a glazed polished surface, sometimes left plain, at others dusted with mica and printed.

Flocks, made from cuttings of wool reduced to a powder and dusted on an adhesive such as gold-size while tacky, are plain or with the pattern in flock, the relief varying according to the number of times they are "flocked."

Ingrains are in reality pulps of a superior class, in which other colour is introduced by additional fibre during manufacture.

Tekko is a beautiful substitute for silk tapestry made on cotton, while *Tekkorex* is a cheaper variety.

Estimating Quantity Required.—Ordinary English wallpapers are 12 yd. long and 21 in. wide. White lining paper, however, is in widths of 22 in., 30 in., and 42 in. French papers, on the other hand, are about 9 yd. long and 18 in. wide. When estimating the quantity of paper required to cover the walls of a room, there are several methods, any of which may be adopted. Find the superficial area of the walls, ignoring windows, fireplace, and door, and divide the sum by the area of one roll of paper. Thus, taking a room 14 ft. long, 12 ft. wide, and 8 ft. high, the area in feet would be the perimeter of the room multiplied by the height—that is $14 + 12 \times 2 \times 8$ ft., and the area of one roll of paper $= 12 \times 3 \times 1\frac{3}{4}$ ft. By dividing the area of the four walls by the area of one roll, the quotient gives the number required, in this instance $6\frac{33}{63}$ rolls, and allowing for waste, seven rolls should be sufficient. Generally speaking, one roll in seven should be allowed for waste.

Another method is to take a roll of paper, and, placing it against the wall, go round the room to see how many lengths are required, counting four lengths to the roll when not more than 8 ft. from skirting to cornice, and three up to 10 ft. in height, the short pieces being reckoned for patching over the window and the door.

Patterns are known as drop and set. With the former there will be more waste than in the latter, avoided sometimes by cutting lengths from alternate rolls.

Paperhanger's Tools.—The necessary tools are a pair of shears with 12-in. blades (Fig. 1); a brush for smoothing the paper on the wall; a 7-in. roller, which should be covered with thick flannel; a seam roll; a scraper; pasting brush; a pasteboard 6 ft. 6 in. or 7 ft. long and 1 ft. 10 in. to 2 ft. wide, with two pairs of hinges on the under-side, so that after use the boards may be folded together (Fig. 2). This board should be of white-wood or yellow pine and ½ in. to ⅝ in. thick. There will also be necessary a pair of light trestles 3 ft. high and 1 ft. 9 in. wide, made of deal 1¾ in. by ⅝ in., mortised and tenoned, the two sides being hinged with 2½ in. backflaps, and when open secured with cords or hooks. A small plumb-line for testing the paper, a 4-ft. straightedge with a spirit level fixed horizontally, and an ordinary 2-ft. rule should complete the outfit.

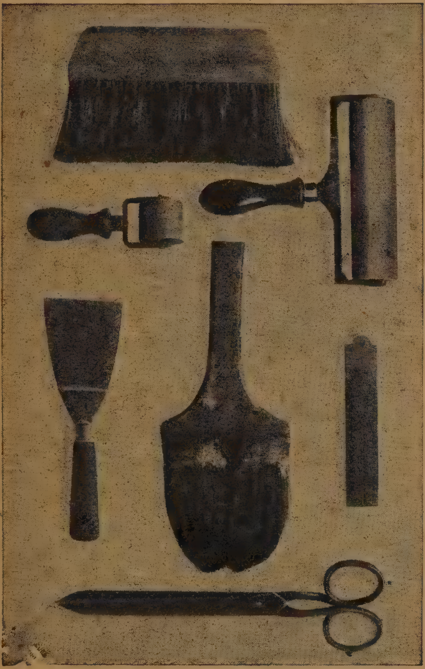


Fig. 1.—Paperhanger's Chief Tools

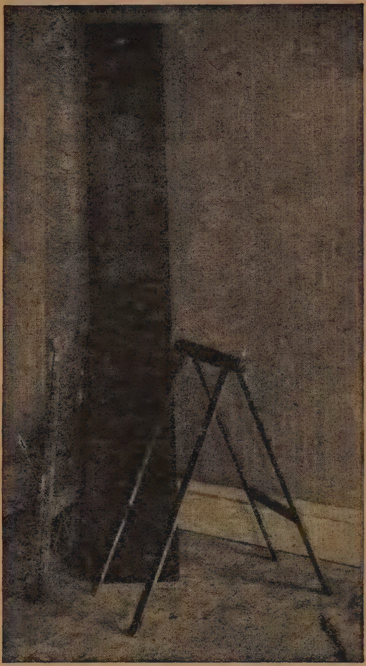


Fig. 2.—Pasteboard and Trestles

Where it is intended to paper only a few rooms, the kitchen table will serve as a bench or board. Two drawers taken out of a dresser and stood on their sides, with two 11-in. boards laid on them, will also answer (see Fig. 3); in fact, some of the best paperhangers appear very well content with this arrangement.

Edging Wallpaper.—The highest-class paperhanging has the joints butted, the commoner sort lapped. For the first, both edges are trimmed close; for the second, one edge is trimmed close and the opposite edge is trimmed within about ⅛ in., or, in the case of thin papers on common work, it is left untouched.

The usual way to edge paper is to sit on a box of a comfortable height, spread out the legs, place the roll of paper on the feet, take one end of the roll, wind upwards with the left hand, at the same time trimming with the right (Fig. 4). If this is found difficult, cut the paper into the required lengths and trim them off separately on the pasteboard. Excellent trimming machines can be purchased, but they would scarcely pay the amateur.

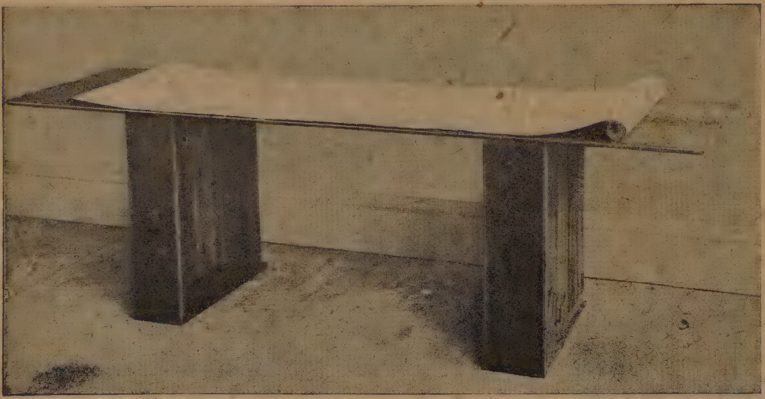


Fig. 3.—Pasteboard Supported on Dresser Drawers

Paste.—The paste for ordinary papers is made with best wheaten flour and boiling water. Take a clean, dry pail and put into it 3 lb. to 4 lb. of flour, and add sufficient cold water to make a stiff batter. Beat free from lumps with a flat stick or spatula. Where there is no gold or bronze in the paper add 1 oz. of powdered alum. Have a large kettle of boiling water, and, when boiling, pour into the batter, stirring at the same time until the paste thickens. Pour a little cold water on the top to prevent a skin forming, and stand aside to cool. If when cold it is at all lumpy, it should be strained through cheese cloth, and, if too thick, cold water in sufficient quantity added.

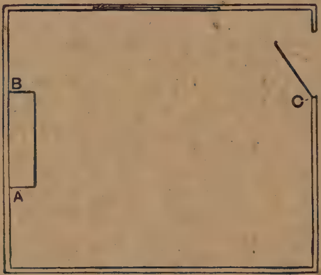


Fig. 5.—Plan of Room

Hanging the Paper.— Before hanging paper, the bare walls must be coated with medium-strength hot size and then allowed to dry. In an ordinary room (see the plan, Fig. 5) the hanging could be begun at the corner A, angle B, or on the side of the door at C, following right round. There are advantages in beginning at the corner A and working over the chimney-breast, as the finish would be in an angle, where, if

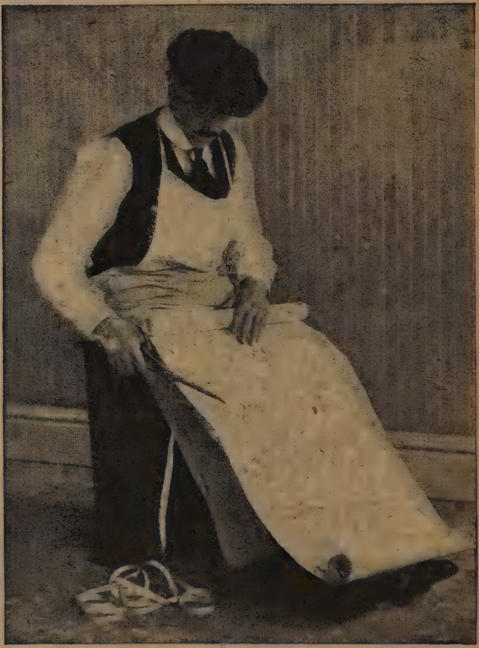


Fig. 4.—Edging Wallpaper

the pattern did not intersect, it would be scarcely noticed ; besides, the laps would not show on entering the room, the edge being from the observer.

If the paper were large in pattern and edged both sides it would be better to begin at the centre of the chimney-breast, working from it in both directions, and finishing over the door. Even if the pattern did not match it could be overcome by scalloping or notching the last piece, so as to prevent a straight line ; there being very little space over the door, this would not show. Where there is a natural break, by windows running up to the cornice, or by cupboards, the matter of finishing is greatly simplified.

The paper being trimmed, take a 3-ft. rule, and mounting the steps (a light pair, about 7 ft. high) measure exactly from the ceiling to the skirting or the bottom of the cornice to the skirting. Spread a roll of paper on the board and decide which part of the pattern shall come close to the cornice. For instance, if there are birds in the design it will not be a good arrangement to have a row of them decapitated just where it would meet the eye. Similar considerations hold good with many other patterns. Measure from the point decided and for the time being, allow the spare paper to hang over the board. Run the roll along the board and measure the length required. Allow at least 4 in. at the bottom, then cut straight across. Bring the roll to the other end of the board and match, allowing the waste to run through, and at the bottom cut through the same pattern as before. Cut the number of lengths required, place them even on the board, then cut the top and bottom level, leaving 3 in. at each end for waste. It will be difficult to cut the lot at one operation ; half a dozen at a time will be easier. They must be cut straight, not obliquely, and if there is a difficulty in doing this employ a T-square. Turn the paper over, so that the plain side is uppermost and the matching edges close to the operator.

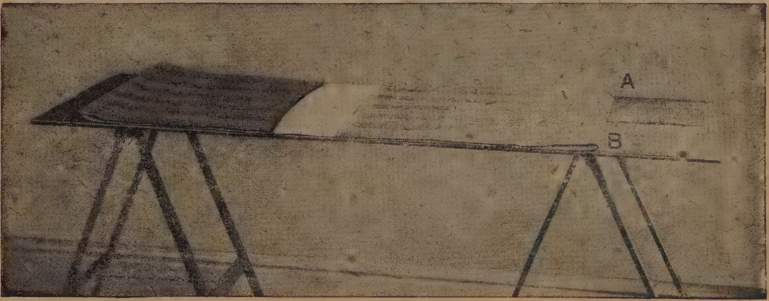


Fig. 6.—Wallpaper on Pasteboard: Top Length Ready for Hanging

To paste a length, push the paper slightly over on the far side of the board. Draw the top length to within 1 in. of the nearer edge, then begin pasting from the left and for the length of the board (there is no need to paste the extreme ends) : now pull the paper flush with the edge of the board and paste this side, working the brush from the centre of the paper outwards. If the paper is 8 ft. long, fold the bottom about 2 ft. 6 in., then draw the paper along, so that the remainder can be pasted. Before beginning, however, push the underneath lengths a little farther back.

When pasted it may be picked up straight away, though it is better to fold it as indicated in Fig. 6. Pick up the paper at the end A B, lay across the left arm, and ascend the steps. When near the wall hold the paper upright in position, and allow the bottom part to drop gently and the top fold to unwind.

As soon as the correct position is ascertained, lightly press the top of the paper on the wall so as temporarily to attach it. Test with the plumb-line, then brush from the centre outwards, beginning near the top. Secure the top, holding the extreme end from the ceiling (or picture rail), while the end of the scissor blades is being run along the angle to make a cutting line (Fig. 7). Pull the paper down a few inches, cut along the mark, brush back, and secure. Descend the steps, unfold the paper by taking one end and pulling gently to its full extent. Brush and secure as above (see Fig. 8). When several lengths are hung, go over the joins with a seam roller.

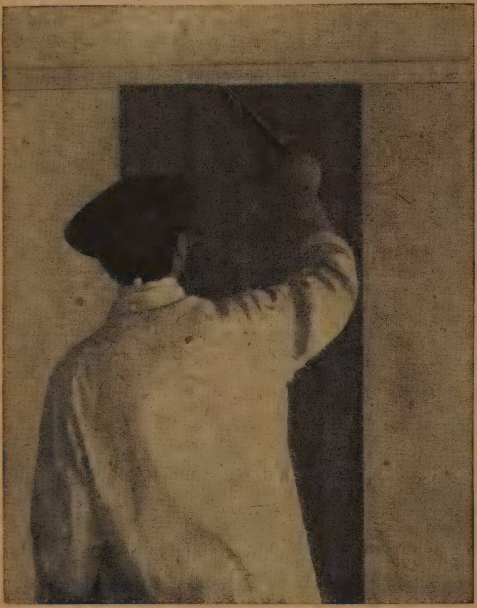


Fig. 7.—Marking Paper at Top with Scissors

Continue hanging round the room, and when an angle is reached fold the paper true, measure the width required from the matching edge, lay a straightedge on top of the paper, and run a guide line with the point of the scissors. In measuring, allow $\frac{3}{8}$ in. to wrap round the angle. Take up the remainder of the length, and hang flush in the angle, testing for uprightness with the plumbline. Continue round the room, doing the patching last.

LINING CEILINGS AND WALLS

Advantage of Lining.—The object in papering ceilings and walls with a plain white paper is to strengthen treacherous plaster surfaces, to give a better foundation for distemper, or to produce a better ground for expensive and delicate wallpapers.

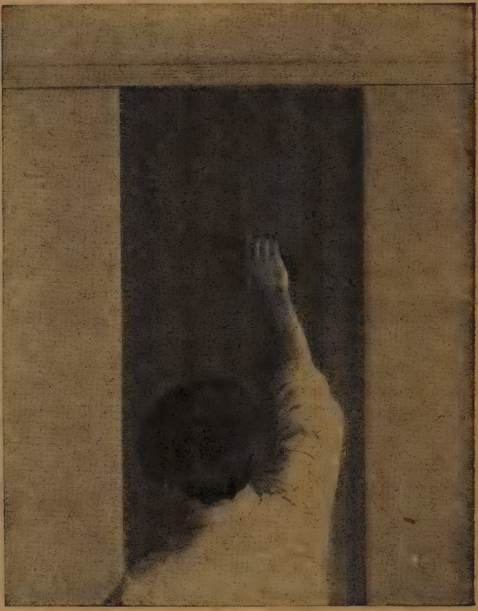


Fig. 8.—Smoothing Paper with Brush

It is doubtful whether wallpapers of superior quality should ever be hung direct on the bare plaster, even though there may be no question as to the wall being dry. Colours in a paper are naturally susceptible to the action of free lime or acid in a wall, or that which may be set free by the presence of moisture in any form, and therefore it is only a proper precaution to prepare a ground calculated to preserve the hanging in sound condition for a considerable length of time. For this reason lining walls with white paper before hanging the wallpaper is strongly recommended. But it is unnecessary in the case of pulps, sanitaries, ingrains, tapestries, satins or lustrettes, and most of the relief materials.

To be doubly sure, a coat of "Rubberose," previous to hanging the lining paper, should be given on treacherous and smoky walls. A coat of petrifying liquid, with the addition of a little "Duresco," or even whiting, is also useful, and may, where these are available, be adopted either with or without subsequent lining. Where the materials mentioned are not at hand, a coat of shellac thinned with methylated spirit may take their place.

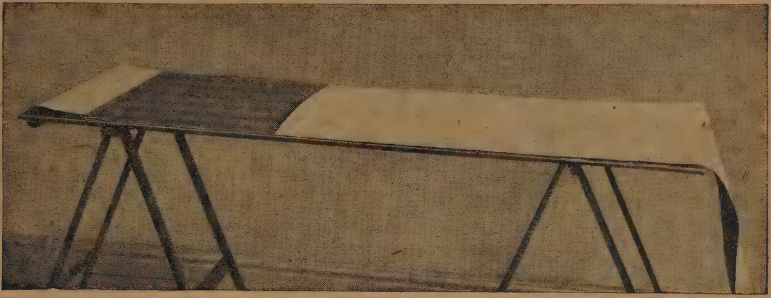


Fig. 9.—First Fold of Ceiling Paper

Lining a Ceiling.—Before lining a ceiling, a coat of hot, medium-strength size must be given and allowed to dry. A running scaffold—that is, a double plank on two pairs of trestles or steps—will be necessary, the paper being hung with the joints running in the direction of the light, or, failing that, with the edges of the lapped paper facing the light so as not to cast shadows. A ceiling that is to be distempered should, except in the commonest work, have the joints of the paper butted, as then they will not be noticeable after the distemper is on. But where very treacherous plaster is being dealt with, full of cracks and inclined to come away altogether in places, the paper had better be lapped $\frac{1}{8}$ in.

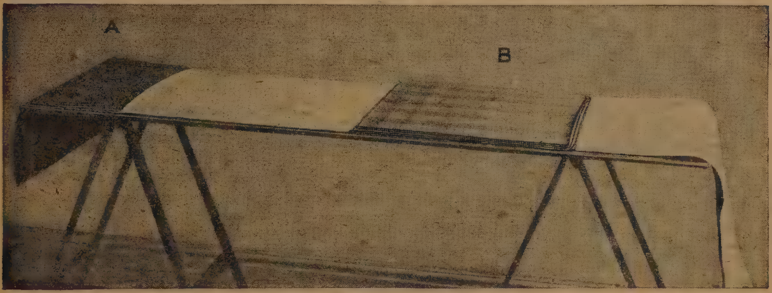


Fig. 10.—Further Fold of Ceiling Paper

The paste should be strained so as to be free from lumps, which would show up badly. The paper should be cut to the required lengths and hung, beginning each length from the window side. The number of lengths is easily calculated by noting how many widths would be required to go along the flank of a wall.

The paper will need folding in a manner different from that adopted when papering walls. Begin pasting from the left, and make the first fold a little more than 2 ft. long (Fig. 9). Pull the paper along (see A, Fig. 10), paste as much as possible, and fold again, doubling the top under as at B, Fig. 10. Complete the length as shown in Fig. 11.

Be careful when pasting to keep moving the underneath lengths so that paste does not get on them. Pick up the pasted length, and, using a partly-used roll of paper to take the weight of the folds, mount the scaffold. Begin near the window, unfold the short end, and, leaving about 2 in. to come down on the wall, brush or roll the paper flat, working from the centre to the edges. When the joints are lapped the paper should be hung so that the uncovered edge is away from the spectator on opening the door. In that case it would be well to begin from the chimneypiece side. Snap a line as indicated at A and B in

Fig. 12, and begin hanging from this, or better still, first hang the two short lengths on each side of the chimney-breast so as to meet the snap-line.

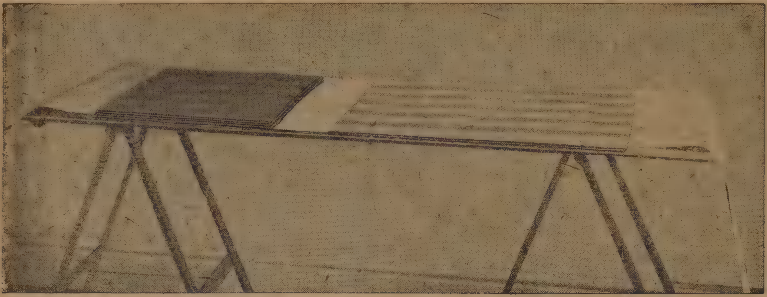


Fig. 11.—Paper Pasted and Folded Ready for Hanging

Where a lined ceiling is to be distempered, ample time should be given the paper to dry, otherwise during distempering it may lift at the edges or other places. One coat of distemper is all that is necessary.

Lining Walls.—In lining walls, the paper is best just lapped, the joints being rubbed down afterwards with glasspaper folded round a cork block.

For heavy relief papers, as lincrusta and anaglypta, it is preferable to hang the lining paper the reverse way to the relief, and in some instances brown will be better than white lining, owing to its greater thickness and to its greater power of absorption.

Hanging Figured Paper on Ceiling.—The places to begin hanging a figured paper on a ceiling depend largely on the pattern. If the design is small, or if it is an over-all pattern, the hanging may be done in the same order as that adopted for white lining. If, however, the pattern is set, or possesses a large leading figure or prominent bunch of flowers, it should, as far as possible, be arranged so that when the ceiling is hung no part of the design appears mutilated by being cut through at some conspicuous place. Snap lines as indicated in Fig. 12, using a bradawl, charcoal, and piece of whipcord or twine, and arrange for a prominent figure to come in the centre of the ceiling. Measure from the centre both ways, allowing at least 3 in. each end for waste. The paper, especially if it be a satinette, must be kept scrupulously clean. No paste must be allowed to get on the under lengths while pasting the top one; while a roller covered with thick flannel will be found better than the brush for hanging.

Fold the paper as indicated in Fig. 11, and hang close up to the snapped line, but without obliterating it. It will be practically impossible to hit on the exact place to start from and keep the paper straight. Begin, therefore, at the window end, and lightly stick the paper on the ceiling, leaving about 1 in. play. Press on temporarily but straight with the line, with the hand, until the centre is reached. Now place the pattern in the correct position, so that the centre of the large design is in the middle of the ceiling and, keeping the edge to the snap-line, roll the further half of the pasted paper to the opposite wall. Return, pull off the first half, then roll back from the centre into its proper place. Cut the ends leaving about 1½ in. on the wall. The first length being up, the paper can be hung both to the right and left of it, matching, of course, at the ends and rolling on direct.

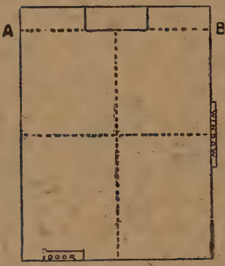


Fig. 12.—Snapped Guide Lines for Use when Hanging Figured Ceiling Paper

It may be said that papering a ceiling single-handed, especially with a pattern paper, requires some practice, and it is an advantage if there is a helper to hold the end with the folds close to the ceiling; failing this, the next best method is to use a roll of paper as suggested.

Paste or Finger Marks on a lining paper which is to be covered with distemper or another paper do not greatly matter; but on a lustrette or an ingrain they mean ruin. There is, so far as the writer's experience goes, no satisfactory way of removing them. Perfect cleanliness is therefore essential. Should paste get on the edge of the board, on the hands or scissors, remove at once with sponge and clean water and wipe dry.

Friezes, Dadoes, etc.—When wall flanks are divided, as indicated in Fig. 13, the frieze A may vary in depth from 9 in. to 24 in., according to the height, character, and style of room desired. Deep friezes seem unsuited to ordinary dwelling-houses, however well they may appear in stately mansions. The picture rail B is not favoured in ordinary rooms as much as it might be, considering its slight cost. The filling C may reach from the picture rail to the skirting, and for low rooms is better than horizontal lines, which detract apparently from the height. Either a chair-rail or a border may be employed at D; but if a border is used, the top of it would be the same height as a rail would be fixed, say 3 ft. 3 in. from the floor. The dado E should be of a pattern differing entirely from the filling, a geometrical arrangement being suitable. Thus if a set design is used on the dado, the filling should have free flowing lines by way of contrast, while if the dado is innocent of vertical lines, they should be found in the filling. Fig. 13 is an example of the effect of parallel lines on the apparent height.

Where a room has its divisions determined by picture and chair rails, hanging the paper is greatly simplified. The frieze may be hung first or last, preferably first, in long lengths, whenever possible from angle to angle, and doubling entirely round the chimney-breast. The roll may be pasted, and the border trimmed while wet, especially if a Ridgeley board and trimmer is being used. Otherwise, it may be found preferable in the case of wide friezes to trim first and paste each length separately. In doing this, lay odd pieces of paper on the board so as not to paste the board.

When hanging a frieze, utilize the steps and plank so that it is easy to run from end to end of a plank, and make sure that the paper runs flush with the ceiling, this part being more noticeable than immediately above the rail.

The filling should be hung, and, if a chair-rail is fixed, cutting is an easy matter. When, however, a border is used instead of a rail, the divisions should be marked off, measuring from the floor, and the lines snapped from angle to angle. These lines may be gone over afterwards with a soft blacklead pencil and a straight-edge. If the border is 6 in. wide, allow not more than 5¾ in. in marking off so as to ensure the border covering nicely.

When arranging for the dado it is best to keep a whole pattern next the border, and the same remark applies to the filling, this being the part where the eye is most likely to rest on entering a room.

Hang the dado, starting from the same point, or, at all events, bringing each joint in a line with those on the filling. The combined charcoal and pencil line should slightly adhere to each pasted length of paper, and give a guide for cutting. The border is hung last, running ⅛ in. on the filling. Some may prefer to make dado and filling paper meet. In any case the line of meeting should be straight, otherwise the difference in thickness will probably be marked when the border is hung and become an eyesore. If this method is preferred, snapping a chalk line should be a sufficient guide for the top of the border.

HANGING RELIEF MATERIALS

For ordinary middle-class houses a dado is most suitable on staircases and along corridors, especially if a relief material is employed and a chair-rail divides the dado from the filling. A paper such as lincrusta or anaglypta, ready decorated or decorated after it is hung, looks well, besides withstanding any amount of hard wear.

The chair-rail may be 3 ft. 4 in. to 3 ft. 6 in. from the floor; that is, 3 in. higher than in the dining-room. Of course, a rail may be dispensed with if ordinary paper is used; but where a relief or japanese paper is selected the chair-rail may be said to be a necessity.

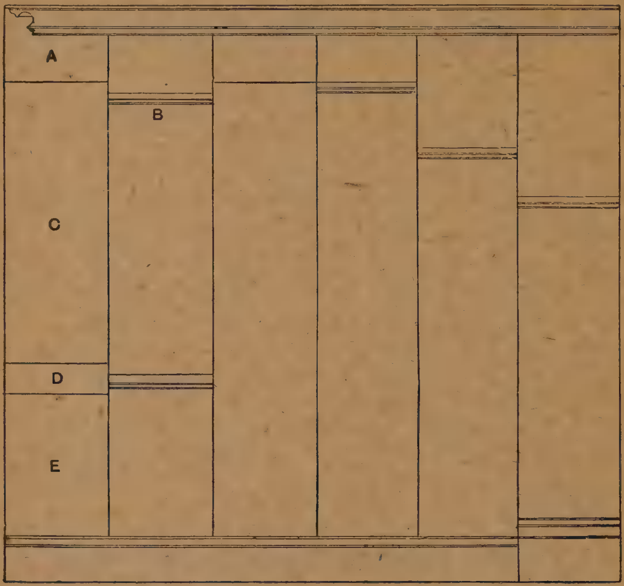


Fig. 13.—Effects of Horizontal Lines on Apparent Heights of Rooms

Staircases.—Suppose, as an example in the method of matching paper on the slant or rake, the staircase is to have the dado covered with a sanitary paper and a 6-in. border. It will be first of all necessary to set out the divisions, and when doing so, always measure from the floor, or the tread, if it be up a flight of stairs. Snap lines from angle to angle along the wall flanks, levelling the line where necessary. Coming next to the staircase, snap lines, keeping the top straight even though the line of the stringing is curved, as it will be difficult to cut and twist the border about to follow the stringing. Continue the marking out right up the staircase before beginning the paperhanging.

The filling on staircases is frequently plain—a paper known as "grounds," obtainable in a wide range of tints—and clean hanging, not matching, is here required. Wide papers, 30 in. or more, are sometimes used, in which case it will be found that the ordinary pasteboard is not wide enough. This difficulty may be readily overcome by obtaining another 12-in. board, securing it flush with the one in use by means of two battens 2 ft. 10 in. by $\frac{5}{8}$ in. by 3 in., fixed with short screws. The battens should be arranged so as to come directly on top of the trestles, and the screws used should not be so long as to come through the face of the pasteboard. It is not wise to attempt pasting wide paper on a narrow board, clean folding being difficult; besides, if the paper is a delicate tint and falls into creases, these will in all probability show up badly on the finished work. A wide kitchen table often answers instead of the board mentioned.

Coming next to the dado, it may be necessary to work from the front door to the rake or springing; but, if possible, avoid having the joints towards the light. In cutting the paper, it is advisable to cut first the number of lengths required for the straight flanks up to the angle, whether acute or curved. This part being hung, the first length on the rake should be measured, matching to the previous one—that is, the straight one. Allow several inches at the top and bottom, and with this length for a guide it should be possible, by noting the rise of each piece, to cut a sufficient number to reach the next angle, as the slant will be the same for each.

If ordinary papers and a border are being hung, the border should be arranged so as not to show a nasty break where the springing begins. Test with a length of the border by holding temporarily in position before cutting and pasting.

Various Reliefs and How to Hang Them.—The relief materials, such as lincrusta, lignomour, and others, require a method of procedure different from that adopted for ordinary pulps and sanitaries. It may be mentioned that the manufacturers issue instructions which should as far as possible be followed. The character of the reliefs varies considerably; thus the method adopted for trimming, pasting, and hanging must be in accord with the nature of the material. Lincrusta has a flat back, and, being made in a mould, the relief is solid. Anaglypta is also run in a mould, but the relief is hollow at the back. Cordelova, lignomour, and cameoid are stamped, the back being hollow. Japanese leather, though a relief material, differs largely from those mentioned, being but slightly raised, and the decoration in beautiful lacquers.

All these materials should be trimmed with a shoemaker's knife, using a steel straightedge 4 ft. or 5 ft. long, and cutting on glass or zinc. A strip of fairly stout zinc 4 in. wide and 5 ft. long will be found most serviceable, and may be fixed on to the pasteboard, though, preferably, on the floor, as more pressure can then be put on the knife, and there is not so much likelihood of the straightedge moving. A heavy weight stood on one end is recommended if the worker is alone.

A paste stronger than the ordinary kind is required. It is made from rye or wheaten flour, and while hot one-third its bulk of strong hot Scotch glue should be poured in, and the whole heated and stirred until thoroughly amalgamated. This paste may be used hot or cold; but when cold it will be found to work very stiff, so that the first is preferable.

When trimming reliefs, the knife should be held at an angle slightly from the operator, so that the material is under-cut. There will then be less likelihood, in the case of ready decorated materials, of a light line showing where the lengths do not properly meet.

It is supposed that instead of using paper on the dado previously mentioned, there is a chair-rail, and lincrusta is to be fixed. First cut the material into the required lengths, then trim it. There will be less possibility of the edges getting damaged, and it will be found easier to trim in lengths. If the lincrusta is already decorated, mix a little dry colour in weak size (the colour being the same as the ground), and run a little on the wall between each length using a small lining fitch for the purpose. This will prevent a white line showing between the material, if the joints are not as close as they might be.

For lincrusta a roller may be used, preferably without the flannel covering, as a fair pressure is necessary. Paste the backs of half a dozen short lengths and lightly fold. In the case of ceilings where longer lengths are required it should not be folded short or the relief may be damaged. Lay the material aside to soak, then take up the first length; if necessary, apply more paste and hang immediately, pressing the paper from the centre outwards.

The top and bottom must be cut in position with the knife and straightedge. Make sure that the edges are down, and if any part is likely to curl drive in a few short gimp pins. Take the next length, unfold, and hang as before. When an angle is reached the material should be cut, and, on the return, the remainder of the length scribed so as to intersect.

Anaglypta may be pasted in the same manner as lincrusta, though it may be found preferable to paste first with ordinary paste, and after fifteen minutes paste again with a strong paste, when it should be hung. It is best not to roll anaglypta, but to press with a cloth or damp chamois leather. In any case the roller must be used but sparingly.

Stamped material must on no account be rolled, or it will stretch and obliterate the relief. When hanging lignomour, stiff rye-flour paste alone should be found sufficient, each length being lightly folded, allowed to remain for fifteen to twenty minutes, and then hung. Cordelova may have the same paste, but should be hung directly without soaking.

When hanging relief materials of any kind, attention should be given to the maker's instructions, though the chief thing to note is the difference in the material. It will be seen at a glance why some papers may be rolled and others not. For the reason that lincrusta is solid, it appears about the best material for dadoes, as it would resist rough usage: it is also the most expensive.

Japanese leather is hung in the same manner as other reliefs, preferably on brown paper lining. The backs of half a dozen lengths should be gone over with a sponge and water, allowed to soak for a few minutes, then the surplus moisture removed. A strong paste is required, preferably with more glue in it. While hanging, a little hot glue is handy, and wherever joints are treacherous they should be secured by running glue down under the edge and pressing the material with a cloth or chamois leather.

Marble patterns are not favoured so much as formerly. These, together with tile patterns, mostly hung in bathrooms, are generally varnished. Papers ready varnished may be bought, but are not recommended, being difficult to hang. Unvarnished paper should be selected the walls well glasspapered and sized. After hanging, give two coats of medium-strength warm size, then varnish with a crystal paper varnish obtained from a good house. If there are any places missed in the sizing the varnish will find them, and turn the paper brown. These, though there should not be any, may be touched up with a little varnish colour similar to the ground just before the varnish sets.

Hanging Relief Materials on Ceilings.—A ceiling is difficult to hang in relief, and it will be necessary to have assistance—that is, someone to take the weight of the folds. When hanging lincrusta on a ceiling, strike a centre line and hang the material from it on each side. When, as is sometimes the case, it is hung in panels, a plan should be made on the floor, using a set-square for the corners and for striking the margin lines, when the material may be cut to the plan. If the room is exactly square and the panels true, it may be possible to cut the material, so that no further cutting is required on the ceiling.

Where a ceiling is in good condition it should be unnecessary to line it for lincrusta, a coat of strong size being all that is required. By the term "good condition" is meant a new ceiling or a ceiling that had previously been distempered and is now washed off bare to the plaster. A painted ceiling, or one coated with washable water paint, would not possess the power of absorption necessary to get a proper grip on the material, which would doubtless spring and open at the joints. Stout lining or brown paper pasted with the same strength paste as that used for the relief and hung the reverse way, would obviate the tendency of the material to move.

Lincrusta ceilings are frequently painted and finished in flatting. One or two coats of oil and the finishing flat coat would be necessary, the first coat being applied without any previous preparation. In the case of cordelova and anaglypta, a preliminary coat of strong glue size should be given. It seems, however, that these relief materials are eminently suited for treatment with washable distemper, and they should present a finished appearance in one good round coat.

Building Model Aeroplanes

So-called "model" aeroplanes of the types described in this chapter are long-distance flyers, and may be regarded as freak machines; they are not models in the true meaning of the term, inasmuch as they are not miniatures of full-size aeroplanes. The practice of making flying models of full-size machines yielded poor results from the flying point of view, for they afforded but few opportunities for studying the laws of mechanical flight. With the freak type of machine, however, flights of well over $\frac{1}{4}$ mile can easily be obtained, whilst enthusiasts who prefer duration of flight, or actual time in the air, can build machines capable of remaining aloft for nearly five minutes. Record machines, however, need to be managed by skilled hands, and it is not therefore desirable for the beginner to build and try to fly flimsy machines of the record-breaking class. It is better to build two or three models of a simple type, proven flyers, so as to gain acquaintance with some of the underlying principles, armed with which experience more difficult machines may then be undertaken.

A LONG-DISTANCE MONOPLANE

The model shown by Fig. 1 is a 200-yard-flight monoplane of the "canard" type, which name signifies that its screws, unlike general practice, are placed in the rear, the machine flying with the small plane leading. Such models are simpler to fly than tractors (screw in front).

The Frame, or Fuselage.—The main-spars are $24\frac{1}{4}$ in. long, $\frac{5}{32}$ in. wide, and $\frac{3}{16}$ in. deep. At points 7 in. from one end and $\frac{1}{2}$ in. from the front they are to be carefully and equally bent a little. The propeller crossbar should be cut $7\frac{3}{4}$ in. long and $\frac{1}{4}$ in. wide and $\frac{3}{16}$ in. deep, and the two crossbars, as shown in the plan and side elevation (Figs. 1 and 2), are $\frac{1}{8}$ in. by $\frac{1}{16}$ in. in cross section. The propeller bar is secured to the two bent longerons by means of light tin fishplates B (Fig. 5), lashed into position. The correct method of lashing is shown by Fig. 4; a length of thread wetted with weak glue is laid along the spar and binding begun. The binding goes over the thread lying on the spar and proceeds in a direction towards the end of that thread. When the length of binding is half or two-thirds done, the first, or idle, end is doubled back over the binding to form a loop, and the binding is then continued over part of the loop. When the full length of binding is reached, there should still be part of the loop projecting. Pass the working end of the thread through the loop. The idle end of the thread is now projecting from the binding half-way or one-third-way along. If it is now pulled tight, it will carry the working end with it and bring it out through the binding. Then the two ends can be cut off close, and all knots eliminated. Such a binding is useless without glue or varnish, as it would soon start to untwist.

The enlarged sketch A (Fig. 5) shows the method of making and securing the bearings, which are cut from thin sheet brass. The light crossbars or braces C (Fig. 5) are simply lashed on tightly without any plate. The binding at the front where the two spars meet must be left until the elevator adjustment is fixed.

The Main Plane.—The framework of the main plane must be lightly constructed of birch scantlings $\frac{3}{16}$ in. by $\frac{1}{16}$ in. The two ribs shown in Fig. 1 above the mainspars and at right angles to them are to be of the same size and

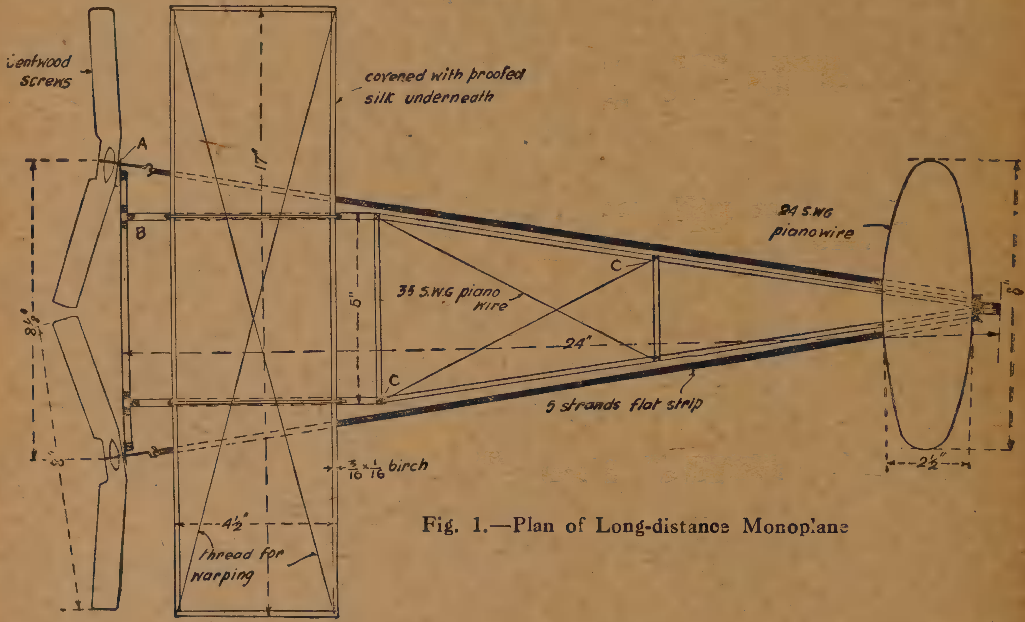


Fig. 1.—Plan of Long-distance Monoplane

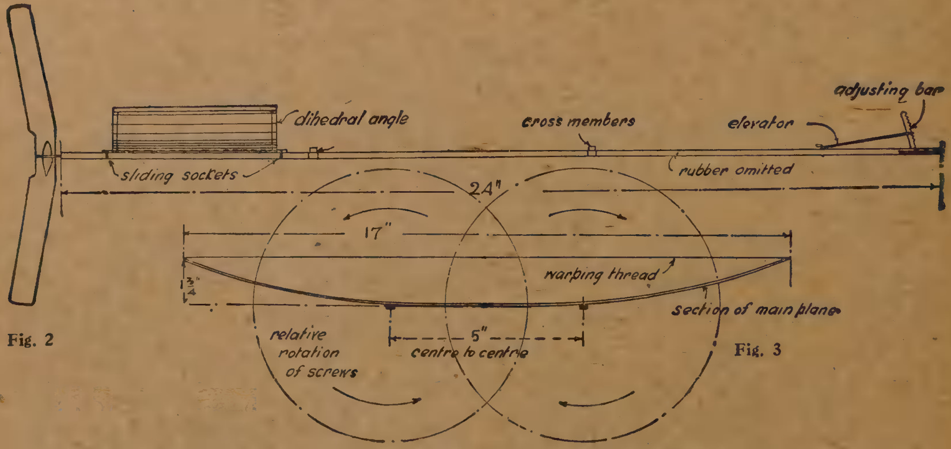


Fig. 2

Fig. 3

Figs. 2 and 3.—Side and End Elevation of Long-distance Monoplane section, and must be cut long enough to project ½ in. on each edge of the plane. The overall dimensions of the plane are 17 in. by 4½ in.; the ribs have therefore to be 5½ in. long. The six joints which have to be made should be glued and further secured with very fine brads or pins. The curved dihedral or rise at the tip of the main plane may be followed in Fig. 3. The versed sine or extent of rise should be made 1¾ in. The spars of the plane need not be steamed to obtain this camber; the cross threads shown in Figs. 1 and 3 will effect it automatically if sufficient tension is applied. By being crossed these threads also serve for warping or twisting the plane, the effect of which will be to make the flight curve to either the right or the left. They further brace the plane and enable an unintentional warp to be taken out, which if left would prevent the machine flying straight.

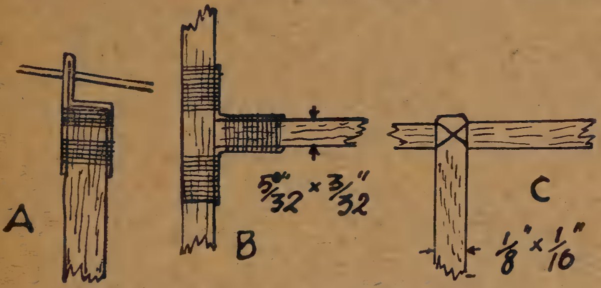


Fig. 5.—Bearing and Frame Joints of Long-distance Monoplane

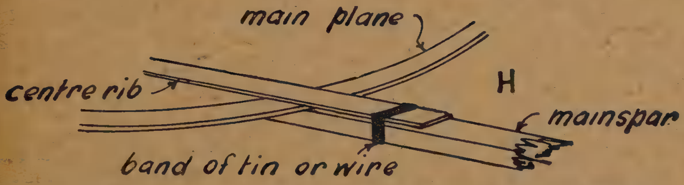


Fig. 6.—Mainplane Attachment of Long-distance Monoplane

The Plane Fixing.—This is a simple arrangement; it is secure, yet enables the plane to be removed for packing or carrying. It also provides an easy adjustment for the plane in a fore and aft direction along the machine, for balancing purposes. The device consists of two ribs on the spars, cut to extend over the plane edges, as previously mentioned, and also of four rings of wire, tinfoil or rubber, two on each frame member. If the ends of the ribs are tapered off on their top sides the rings will slip up them and wedge the plane securely on to the frame, as shown in Fig. 6.

The Elevator and Its Adjustment.—Cut from a piece of thin brass the curved quadrant piece (see Figs. 2 and 7) which is to form the elevator adjustment. In the outside edge of this file a number of notches just deep enough to allow a piece of 20-gauge wire to seat home snugly in them. The elevator is oval in plan (see Fig. 1), and in the centre of the front edge a loop is bent to slip over the notched quadrant. The elevator, when the fabric is stitched on, should have space left in this loop to allow the quadrant free movement. At the rear or trailing edge the elevator is secured by means of two pins passing first through the frame, then through the fabric and over the wire edge of the elevator, as shown in Figs. 7 and 8.

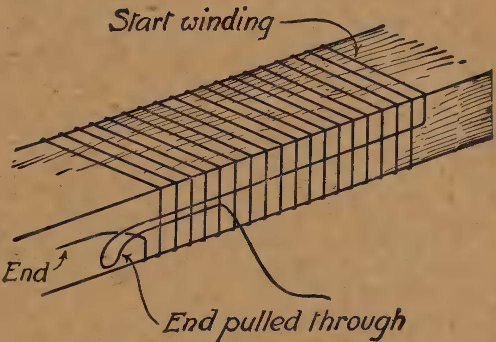


Fig. 4.—Method of Lashing Spars, etc.

The Propellers.—These are, of course, of right- and left-hand pitch, and are 8 in. in diameter. The pitch should be about 20 in., and the greatest care is necessary to ensure that the pitch angles of the four blades are alike. The screws are only shown conventionally in the plan and elevation, but Fig. 9 gives a view of the finished screws, and Fig. 10 the operation of bending. Before bending, the line upon which the blade is to be bent is marked on each blade; of course, this line is disposed equally from the shaft on the four blades. Now hold the blank in a strong jet of steam and moving the blank in it along the direction of one of the lines (a word of warning: bend only *one* blade at a time) bend the blade gradually to the desired extent. Bend the blade *away* from the jet so that the convex side of the blade is nearest to the steam. It will be noticed that the steam imparts a little camber to the blades, which is desirable. View the blank from the tip and notice the angle it makes with the shaft. The angle should be slightly more than necessary to allow for flattening out. Serve the second blade similarly, only bending it in the *opposite* direction. The second propeller, it must be borne in mind, must be made of opposite pitch, as shown in Fig. 9.

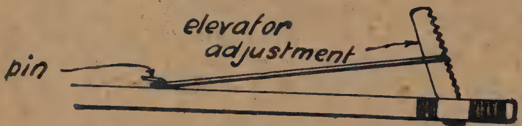


Fig. 7.—Elevator Adjustment

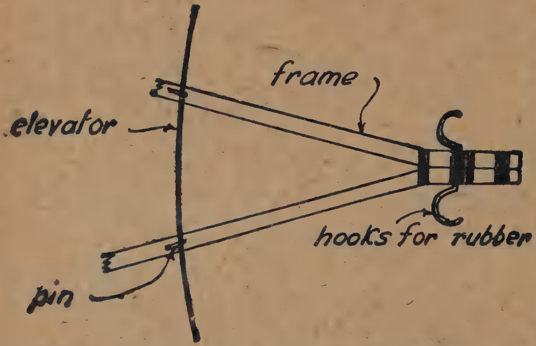


Fig. 8.—Elevator Attachment for Long-distance Monoplane

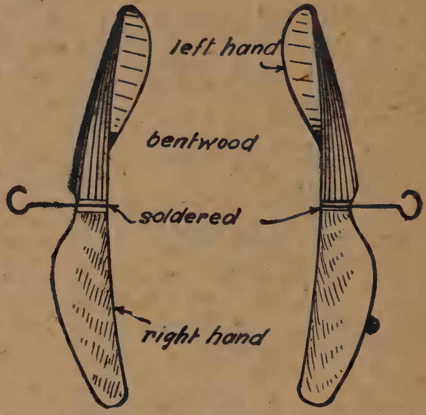


Fig. 9.—Finished Screws for Long-distance Monoplane

To complete the model, connect the front hooks to the propeller hooks by means of five strands of $\frac{1}{4}$-in. strip rubber to each screw. The rubber should be lubricated by means of pure soft soap.

A RISE-OFF-GROUND MONOPLANE

Figs. 11 to 13 show a rise-off-ground monoplane of a design that has proved very successful. Unlike the machine previously dealt with, this has a T-frame. Constructional details, however, do not

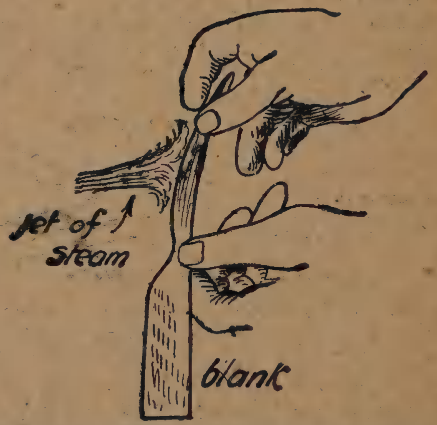


Fig. 10.—Method of Bending Airscrew Blank

radically differ from the preceding machine. The fact that the machine will rise from the ground under its own power gives it added interest.

The Fuselage.—This is 3 ft. 3¾ in. long and ⅜ in. by ¼ in. in section, the smaller measurement being disposed vertically. It is slotted at two places to receive the kingposts, as shown in the side elevation (Fig. 11). From these kingposts pass fine bracing wires which give rigidity to the spar. The propeller bar and supports with bearings are fixed in a similar manner to those in the long-distance monoplane, and do not call for comment.

The Main Plane.—This should be made as described earlier, except for the centre rib, which needs special treatment. It is shown in detail in Fig. 14. As will be seen from Fig. 11, a kingpost passes through the main plane, the two being attached. In order to accommodate this, the rib is slotted (Fig. 14). To each kingpost small removable tinfoil caps are attached so that the model may be dis-

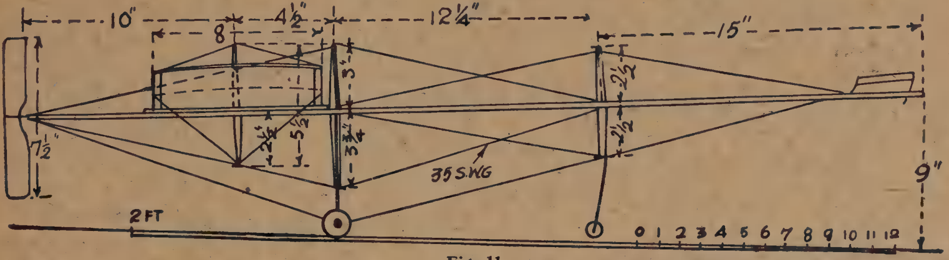


Fig. 11

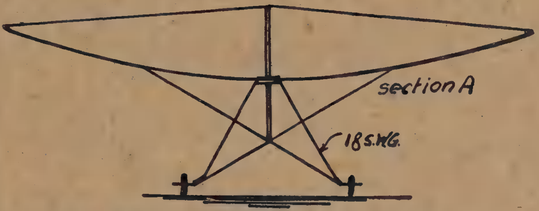


Fig. 13.—End Elevation of Rise-off-ground Monoplane

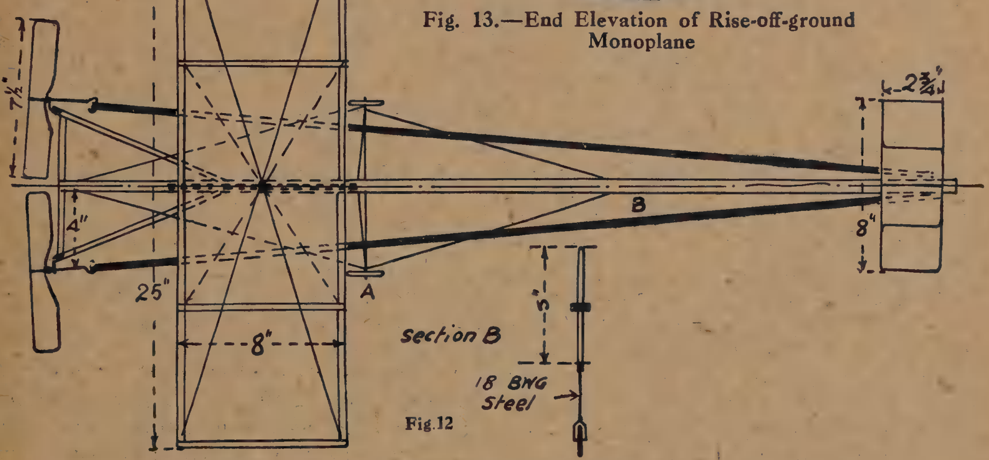


Fig.12

Figs. 11 and 12.—Side Elevation and Plan of Rise-off-ground Monoplane mantled for portability. The mainplane centre rib extends fore and aft of the leading and trailing edges, is slotted out as shown in Fig. 14, and is finally secured to the fuselage by means of swivelling pins (see Figs. 14 and 15).

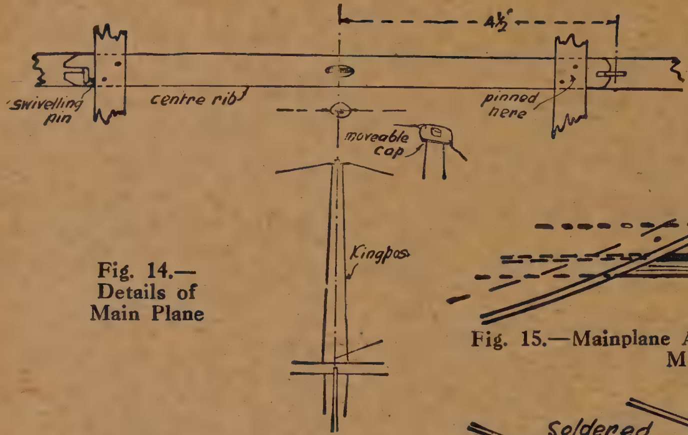


Fig. 14.—Details of Main Plane

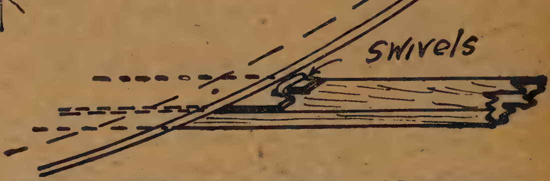


Fig. 15.—Mainplane Attachment of Long-distance Monoplane

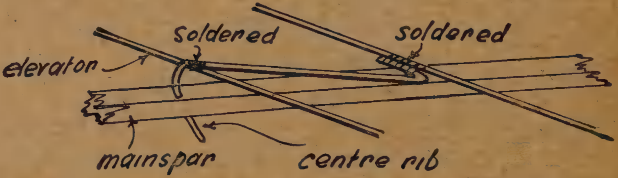


Fig. 16.—Elevator Adjustment of Rise-off-ground Monoplane

The Elevator.—This is a rectangular plane made from one continuous length of wire. The adjustment is effected by means of a continuation of the centre rib (Fig. 16) which causes the trailing edge to bind on the spar and so retain it in place. It can, however, swivel should it strike a fixed object during flight. It is preferable to stitch the fabric to this plane, as glue cannot make a satisfactory joint on wire.

The Chassis.—Fig. 17 shows clearly the form of the front and rear chassis. The axle of the main chassis passes through the kingpost, to which it is bound and lightly soldered; the bracing wires are taken from the points shown, these being more clearly indicated in Figs. 11 and 12.

Materials.—The following list represents the complete set of materials: Motor spar, 3 ft. 6 in. long by ⅜ in. by ¼ in. (spruce); bearing crossbar, 6½ in. by $\frac{3}{16}$ in. by ⅛ in. (birch); bearing crossbar struts 8½ in. by $\frac{3}{16}$ in. by ⅛ in. (birch); outriggers, 6½ in. by ⅜ in. by $\frac{3}{16}$ in. (birch); mainplane spars, 25 in. by ½ in. by $\frac{1}{16}$ in. (birch); mainplane ribs, 8 in. by $\frac{3}{16}$ in. by $\frac{1}{16}$ in. (pine or spruce); mainplane centre rib, 9 in. by ½ in. by $\frac{1}{16}$ in. (birch); propellers, 7½ in. by 1½ in. by $\frac{1}{16}$ in. (birch); steel wire for elevator, 28 in. (18 s.w.g.); steel wire for chassis, 62 in. (18 s.w.g.); steel wire for spindles 14 in. (18 s.w.g.); steel wire for bracing, 2 reels (35 s.w.g.); wheels, pair, 1¾ in. diameter, and one ¾ in. diameter; silk airproof fabric, 27 in. by 11 in.; silk airproof fabric, 8 in. by 3½ in.; wire strainers, two; brass wire, 3 in.; elastic, 1½ oz. to make two skeins (¾ oz. each).

A WINDER FOR MODEL AEROPLANES

Figs. 18 and 19 show a geared winder for winding the elastic motors. Formerly the egg-whisk has been improvised for this purpose, but the present device enables the model to be wound without the aid of a second person. It is forced into the ground for use, one hand manipulating the winding crank and the other supporting the model in the chuck (Fig. 18). Soldering is not sufficiently effective to withstand the torsion placed upon the shafts by the rubber when it is in tension, although silver-soldering and brazing would be suitable. The form of drive shown in Figs. 18 and 19 eliminates these processes. The large toothed wheel has its bore filed out to suit a square filed on the spindle, the end of the latter being turned down to a pivot point to locate it in the brass casing. The other end of the spindle is slotted to receive the handle crank, which is held therein by means of a split pin. Details of the attachment of the handle are given by Figs. 20 and 21. The hardwood stump is chiselled round to a conical form to receive a brass or tinplate socket to facilitate its being forced into the ground. This socket is shown developed from the flat sheet in Fig. 22. It is then formed and screwed to the stump, and the joint of the two edges may be soft-soldered.

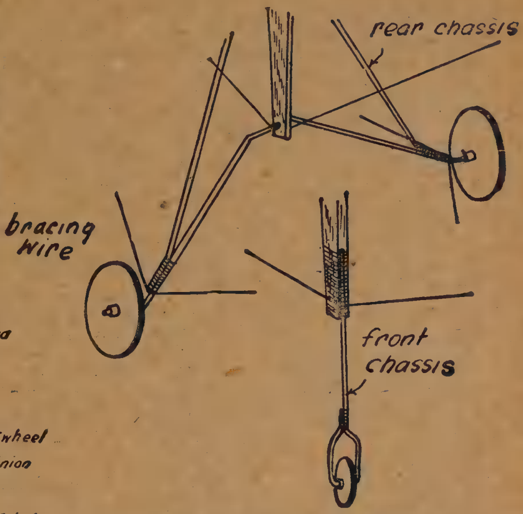
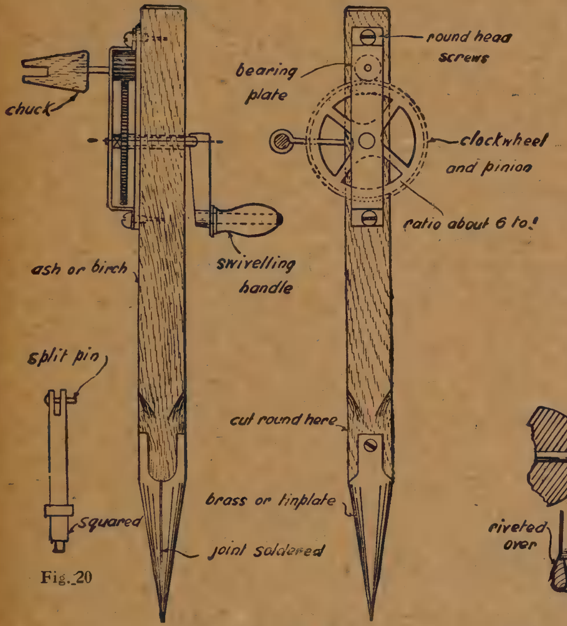


Fig. 17.—Front and Rear Chassis of Rise-off-ground Monoplane



Figs. 18 and 19.—Winder for Elastic Motors

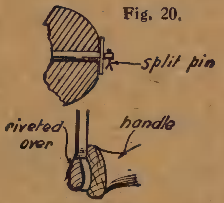


Fig. 20.

Fig. 21

Figs. 20 and 21.—Handle Details

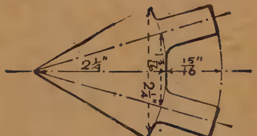


Fig. 22.—Socket Developed from Sheet Metal

The wheel and pinion spindles should both be of silver steel.

The gear casing is provided with a back plate so that the mechanical portion is self-contained and merely held to the stump by means of two brass round-headed screws. The chuck driving the propeller must be of hard wood, such as ash, to obviate splitting when being driven on the pinion shaft. The end of this shaft should be filed to a chisel edge, so that it may cut its way into the wood. The ash stump should be 1¼ in. square.

SETTING OUT AIRSCREWS

The method of setting out model air-screws applies, with modifications, to the full-size screws also. The important thing is to ensure that the *pitch is constant at any point along the blade.* For example, if the propeller tip has a pitch of 30 in. (that is, one revolution theoretically takes the machine forward 30 in., although practically it will be something short of this due to the yielding nature of the air) and the blade at the centre is of only 25-in. pitch, obviously the central portion is acting as a drag upon the tips. A (Fig. 23) is a side elevation of a carved screw, and B (Fig. 24) a front elevation. C (Fig. 25) shows a portion of a side elevation with the pitch angle at eight different points plotted. D (Fig. 26) represents the block from which the screw is cut, and E (Fig. 27) is an end view of the finished screw, with the pitch angles also plotted.

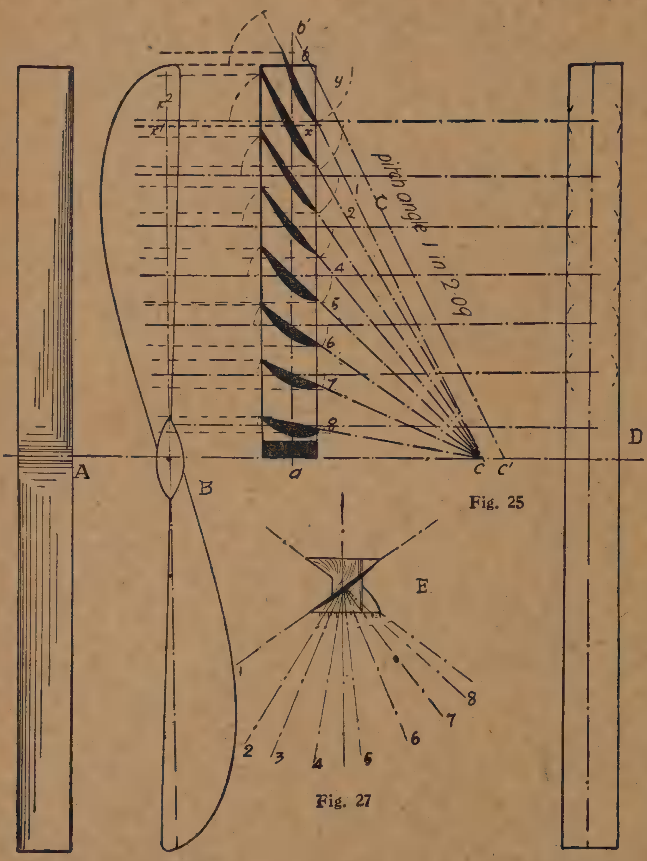


Fig. 23 Fig. 24 Fig. 25 Fig. 26 Fig. 27

Figs. 23 to 27.—Diagrams Showing the Setting-out of Carved Air-screws

In setting out an air-screw, Fig. 25 is first drawn, the axial lines passing through *a* and *c*. Next erect a line at right angles, as *ab*, representing the centre line of the blades. On each side of *a* mark the width of the blank at the centre, and mark off the distance *b* equal to half the diameter. Having determined the pitch angle—in this example, 1 in 2·09, when the pitch of the screw will be 1½ times the diameter—set off a distance *ab*, which is equal to the circumference of the circle swept by the screw = 3$\frac{1}{7}$ × diameter. Mark off the pitch along the line *ac*, thus fixing point c^1. By connecting b^1 to c^1, the pitch angle is determined; parallel to this line draw another line cutting through *b*, thus locating point *c*. By subdividing the line *ab* into a number of equal parts (in this case, eight), and connecting the points so obtained with *c*, the pitch angles at those points are determined. Two or three points only would be sufficient for model screws, but it follows that the greater the number of angles taken, the more efficient will be the screw.

The angles may now be projected to Fig. 24, and the lines marked x^1, and the radii x^2 show how this may be done.

Fig. 28 shows a model driven by compressed air; in such models the accurate development of the screw by the method outlined above is essential, as the power cannot be varied as with a rubber-driven machine. The smaller the diameter of the screw the less is the number of points it is necessary to step off. The pitch angle for single-screw machines should be one and a half times the diameter, and for twin screws any particular proportion so long as it exceeds $1\frac{1}{2}$ diameters but does not exceed $3\frac{1}{7}$ diameters, when the pitch angle is 45°; this is known as the critical angle and is the point of maximum efficiency.

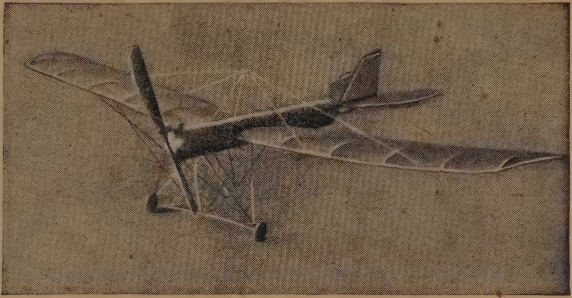


Fig. 28.—Compressed-air Model Monoplane

The width of blade should be from one-eighth to one-twelfth of the diameter, the former ratio if under 12 in., and the latter if over 12 in. Screws of large diameter and short pitch are preferable to those of short diameter and long pitch, absorbing more of the power of the motor and giving a minimum amount of slip or lost power. Tractor screws should be of slightly coarser pitch than would be used for a canard (propeller behind) machine of similar proportions.

How to Make a Copper Lid

A copper lid is necessarily made of wood, because iron or other metal would damage the clothes, and for the same reason it would not do to fix the wood lid together with nails or screws. Wood pegs must be used, and the best way to do this constitutes the whole difficulty in the making of the lid. The wood must be non-resinous.

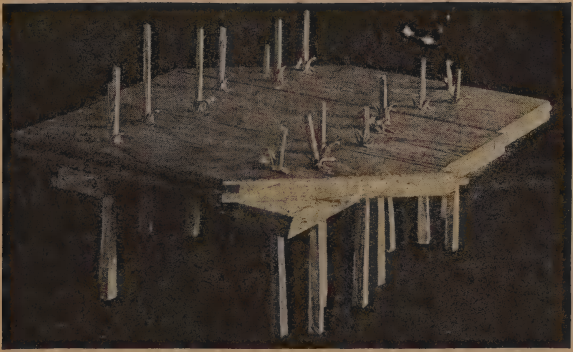


Fig. 1.—Making Copper Lid: Pins Prepared for Wedging

A copper lid should be formed with boards tongued together at the joints, and held together with ledges running at right-angles to the boards, there being a handle by which to lift the lid. The size of the finished lid should be the same as the outside diameter of the copper, so that it will rest on that only, and not on the brickwork or cement setting. Therefore, if the copper is 20 in. in diameter inside, the lid will have to be 23 in. in diameter when finished. There will thus be required four $6\frac{1}{2}$ in. by 1 in. tongued and grooved boards, and to hold these together two ledges will be wanted, say 4 in. wide by 1 in. thick. Two of the main boards must be the full length of the proposed diameter of the lid, but the other two, as well as the ledges, may be about 3 in. less in length.

The boards should be planed flat on the better side, also the ledges, and the edges of the latter should be bevelled with a flat bevel, as shown in the accompanying photographs, and then they can be laid together, in the position they will have to be fixed in, taking care that the ledges are at right-angles to the main boards, and that they are at equal distance from either side, so that the finished lid will not appear lopsided. The correct distance from each edge is about 4 in. for

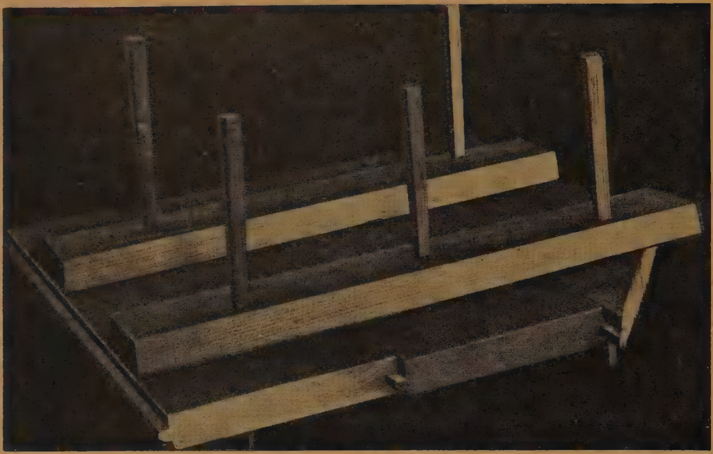


Fig. 2.—The First Pegs Driven In

the size of lid here considered, and more or less for one larger or smaller.

While the lid and the ledges are held tightly together, two or three holes about $\frac{5}{16}$ in. in diameter should be made through them, and in these holes slightly tapered square pegs must be driven, as in Fig. 2, to hold the boards together while the other pin-holes are bored, and when this has been done, the whole of the pins can be driven in, thus making the lid appear as Fig. 3. In boring the holes, keep the boards and ledges close together; otherwise the chips taken out by the boring bit will get between them and spoil the joint.

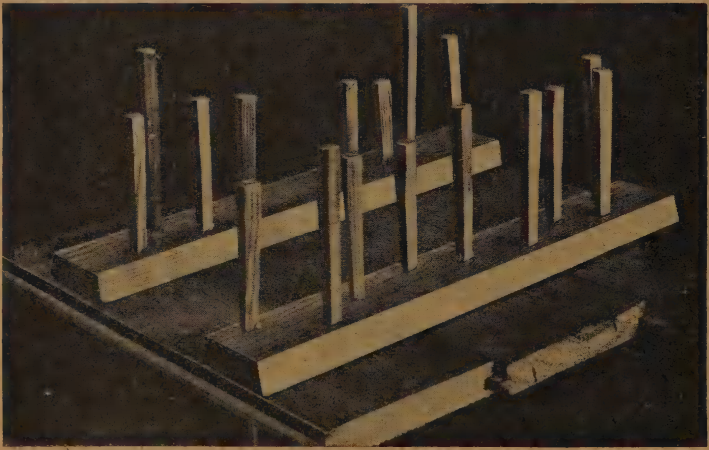


Fig. 3.—Square Pegs Driven In

All the pins inserted, the lid must be turned over, each pin must be cut in with a sharp chisel, so that the upper part will form a wedge, which can now be driven tightly into the bottom part, thus fixing each pin firmly. Fig. 1 shows some of the pins prepared for wedging and others with wedges driven.

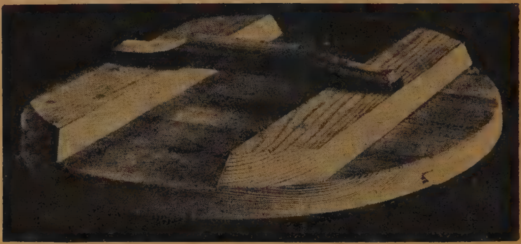


Fig. 4.—Finished Copper Lid

The whole of the wedges and pins can now be cleaned off level, and the lid planed on the sides where required, and then it can be marked to the circle, cut round, and finished off with the spokeshave.

The fixing of the handle (Fig. 4) will finish the lid. The handle must be fixed with pins in the same way as the ledges, two in each end. Do not be tempted to use round pins, as they will not hold so well as the square ones, and will be more liable to split the wood in driving them in.

Restoring an Old Elm Table

THE photographs (Figs. 1 and 2) show an old table which had lain discarded for many years in an outhouse. It was in a very shabby, neglected condition, and needed to be well brushed over before being photographed It was recognised as a genuine old piece of furniture, and well worth the time and trouble of restoring. This, however, is no light task. Owing to neglect, it is much worm-eaten, as may be expected, for to remain long in such condition is very favourable to grub. It bears evidence of having been repaired by the united efforts of the village blacksmith and carpenter—which is quite a common thing with such articles. There are many tables about, of a somewhat similar make, more or less out of condition, and the information here given will be useful to anyone interested in their restoration.

Plenty of time must be allowed to do the work, this being essential principally on account of the treatment required to cure it of grub.

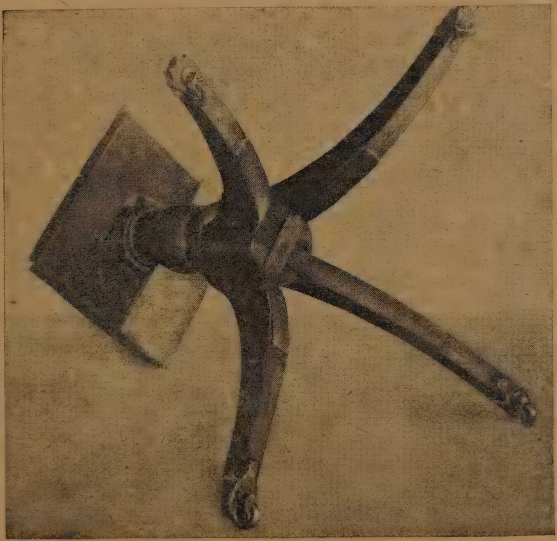


Fig. 1.—Old Table to be Repaired

It is rather a large table, the top being 5 ft. by 3 ft. 6 in. One of the faults in its design or construction is that it was not fitted to the stand with thumbscrews and a snap-catch, so that it could be lifted off, it being too heavy and awkward to be lifted about easily. Instead, the top block of the stand has been made with wood pins at the two back corners to fit into holes in the rails of the supporting frame; this is the usual style with small tables having a top of about 18 in. diameter. One of these pins has become broken off (see A, Fig. 3), and some attempt has been made at fixing by nailing on the piece of wood shown at B (see also Fig. 1). The first thing to do is to knock this off and dispense with it; then take off the brass claw-feet casters. These are a very good set and are still in good con-

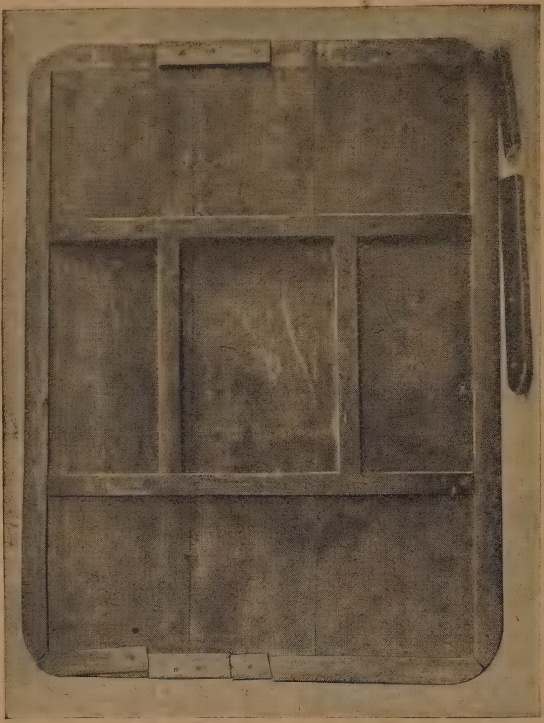


Fig. 2.—Old Table-top

dition, except for being tarnished (see Fig. 4), and two of the wheels are worn at the centres, as shown at c, Fig. 5. The two photographs show also the damage effected by worms.

The screws are rusted in and difficult to remove, and care must be taken to avoid breaking them, which mere force would certainly do, and they would then give further trouble. The flame of a spirit lamp is applied to dry the wood and heat the screws, and when cool they are found to yield much more easily. The casters are repaired by punching out the pins to remove the wheels, new solid brass centres being next fitted, brazed in, and then drilled and replaced with the same pins. When cleaned and lacquered they will be almost as good as new.

It is a common practice with these tables when the legs get loose to fit them with iron bands on the underside and end of the turned pillar, as shown in Fig. 1. But though this is useful in keeping them on, it does not make them steady unless the joints are refitted and glued. It is essential that they should be quite rigid. In this case three of them are not rigid, and must be taken off, so it is necessary to remove the irons. Here, again, the screws require careful manipulation; some of them may turn in the wood without coming out, and will therefore need to be prised up with the screwdriver, as in Fig. 6. The loose legs are next knocked out of the dovetail slots in the pillar, each having been previously marked. It will be easily understood that though the block seems only slightly loose on the pillar, when the large, heavy top is on it would appear very loose indeed. Therefore, it must be taken off to be properly fixed. It is double mortise-and-tenon jointed, and is undone by butting a piece of hard wood against the tenons and per

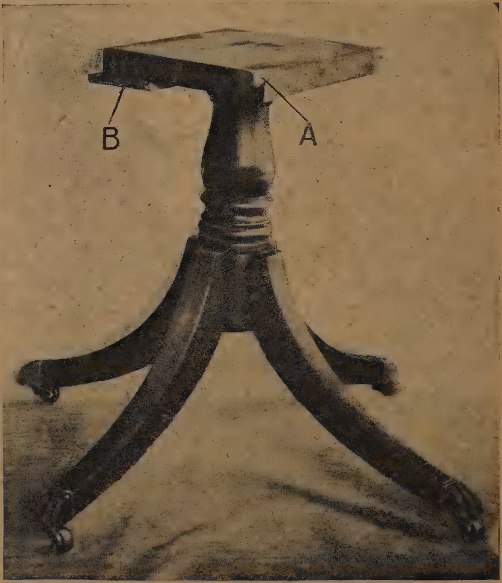


Fig. 3.—Pin Broken from Block

suading with the mallet, resting the block on the bench to keep the leg from being strained on the floor (see Fig. 7).

The table-top is next taken in hand. It is of elm, which is hardly a suitable wood for the purpose (unless it is very thoroughly seasoned) owing to its tendency to warp, as this has done, although it might be all right for the turned pillar, legs, etc. There are two broken joints in the top, and it has to be taken altogether to pieces. Most of the screws in the clamp pieces on the under-side of the reeded edges yield to the persuasion of a powerful screwdriver, but a few are obstinate. Striking the screw with the hammer will sometimes loosen the rust, but there is risk of breaking the screw-head. It is better, with the point of the screwdriver in the slot of the head, to strike the butt end as in Fig. 8. Extra turning power may be given by using a screwdriver bit in the brace, as in Fig. 9. Even this is not always effective until the screw has been heated by holding a red-hot poker on it. When the screw turns in the wood without drawing, as this one, it must be prised up with a chisel, as in Fig. 10.

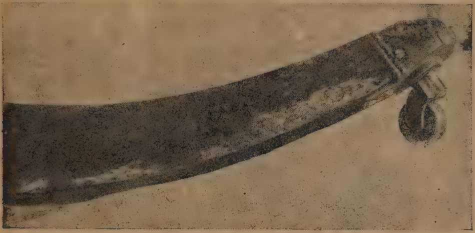


Fig. 4.—Claw Foot with Caster

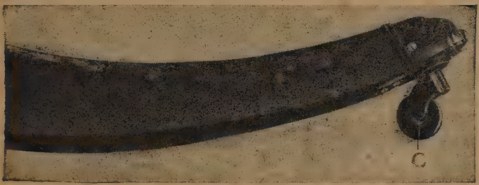


Fig. 5.—Worn Caster on Claw Foot

The framing also is fixed with screws, the heads being sunk about 1 in., and the holes filled with wood. Before taking it off it is marked, so as to know its correct position on the top. The wood plugs are picked out of the screw holes with a bradawl, to be used again; then the screws are taken out.

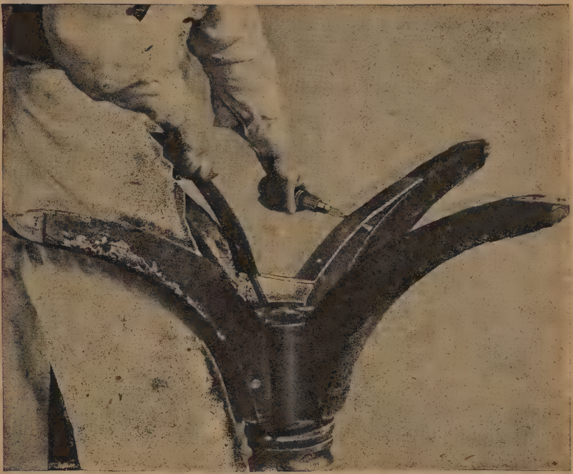


Fig. 6.—Removing Irons from Table Legs

The table is now successfully taken to pieces (see Fig. 11), which is an important part of the work done. In this condition it can be the more thoroughly treated for curing the grub. It is decided to fumigate it with sulphur as a first remedy, so it is set out in a small empty room. Four bricks are placed in the middle of the floor and an iron bucket on top. All apertures, window crevices, etc., are pasted over with paper, the object being to make the room as air-tight as possible. A couple of shovelfuls of red-hot coals are thrown into the bucket and finally a saucerful of sulphur, the door being shut immediately and pasted round on the outside. The quantity of sulphur must always be judged according to the space to be filled. The stronger the fumes the more effective they are likely to be; but if very strong, the odour

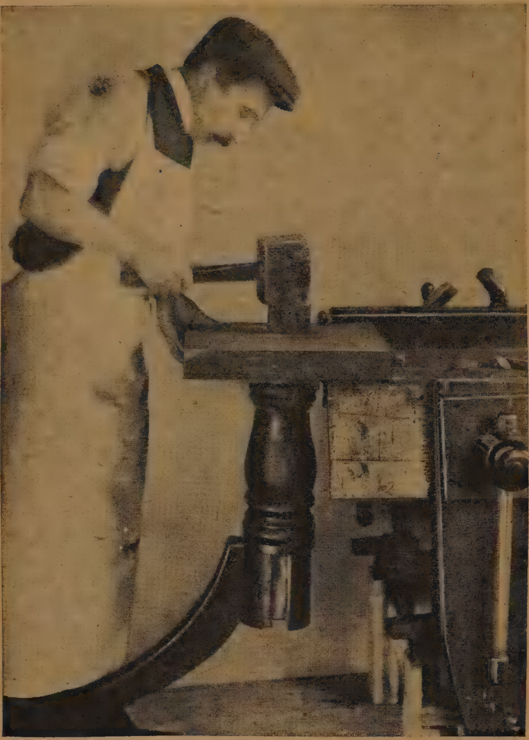


Fig. 7.—Knocking Out Loose Pillar from Block

may remain about the room for months afterwards. If the table can be left for a week in the closed room, so much the better. Arrange, if possible, for the window to be opened from the outside before undoing the door, or slightly open the door and leave the room to clear itself of the sulphur fumes before attempting to enter. The table parts are removed and well dosed with a solution of corrosive sublimate (very poisonous) three times during the next fortnight, and they are then again fumigated with the sulphur.

Before starting the repairs the table is scrubbed clean with hot water containing black-ash used as soda, and then well rinsed with clean water and left to dry.

In repairing, all the glued work must be done as soon as possible. The first thing is to joint the top. There are two joints to be re-made, but only one can be done at a time. The joint edges must be shot quite straight and square with the try-plane. For this the plane-iron is well sharpened, and set fine and true. When both edges are shot

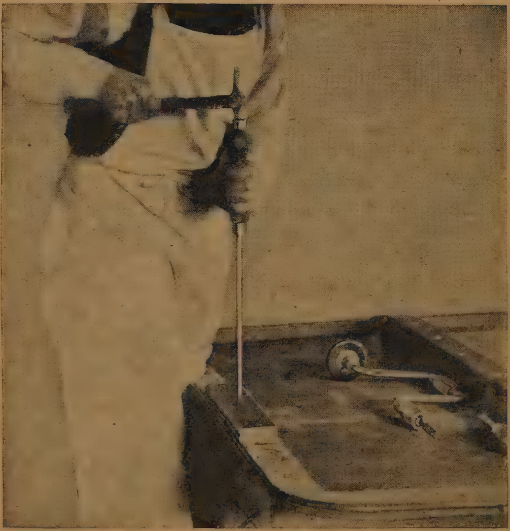


Fig. 8.—Loosening Stubborn Screw

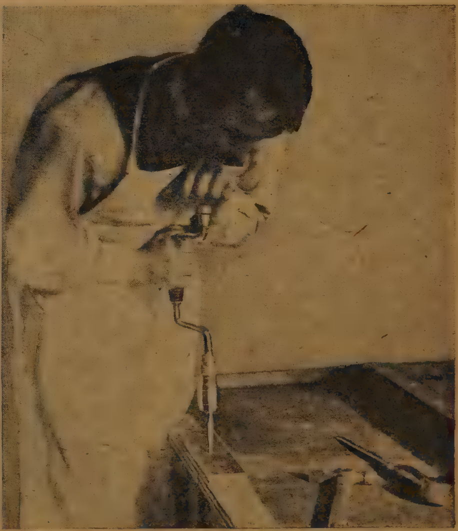


Fig. 9.—Using Screwdriver Bit in Brace

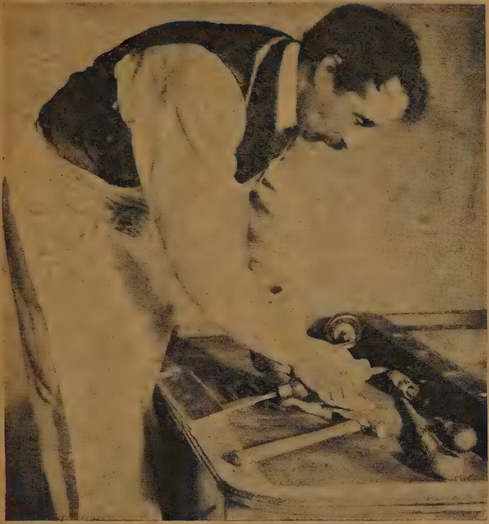


Fig. 10.—Prising-up Clamping Piece

Fig. 12.—Glued Joint in Table-top, Showing Straightening Bits

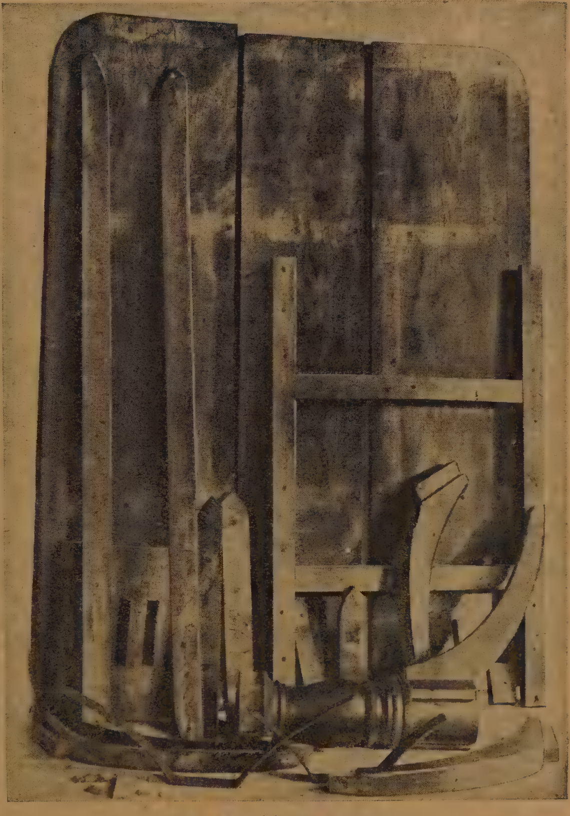


Fig. 11.—Table in Pieces

they are tried together, and to be correct they should be quite straight with each other, or the merest shade round on the face side. They should fit together as perfect as possible at the ends of the joint, but should be a shade hollow at the centre, at which place it should be just possible to discern the light between. Owing to the boards being warped, the joint edges are not level on the face of the boards, and will require the straightening bits of wood to be screwed on, as described in detail on pp. 247 to 249 of this present volume; on pp. 247 to 250, also, similar rejointing work to the present job is fully illustrated. When the joints are ready for gluing, the edges are well heated to keep the glue from chilling too quickly. The heaviest and widest board is replaced in the bench-vice, and two small tools are stuck into it to rest the other board on in a position to have both joint edges level, to be glued at the same time. It must be done thoroughly and

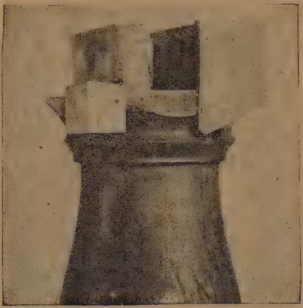


Fig. 13.—Repaired Pillar in the Rough

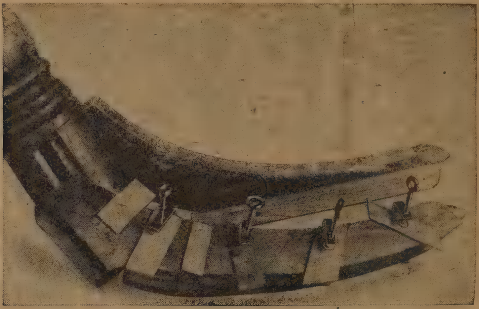


Fig. 15.—Repaired Legs in the Rough

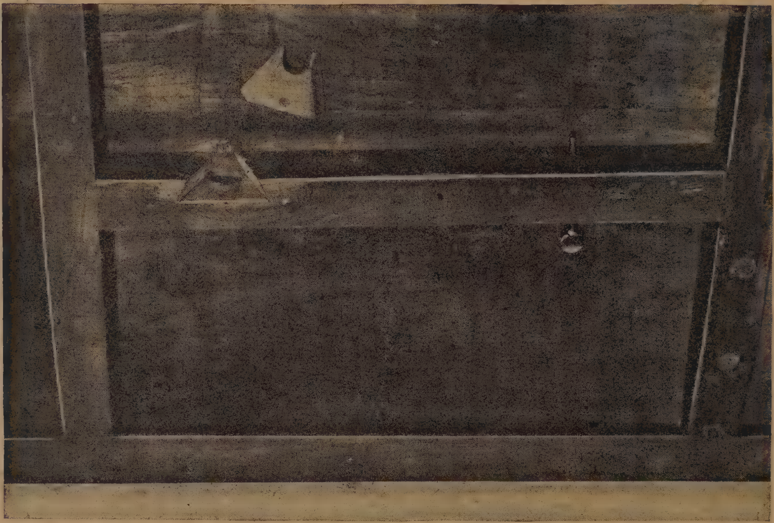


Fig. 17.—Underneath View, Showing Device for Easy Detachment of Table-top

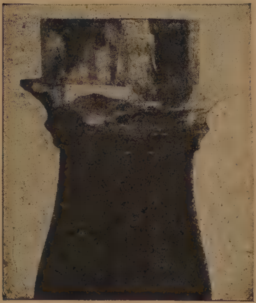


Fig. 14.—Repaired Pillar Trimmed to Shape

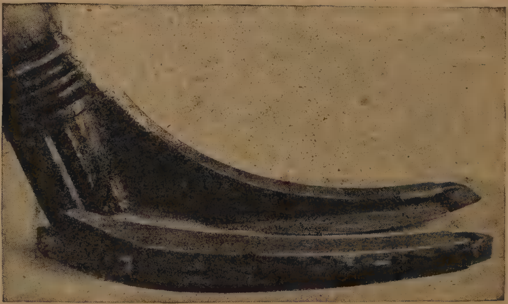


Fig. 16.—Repaired Legs Trimmed to Shape

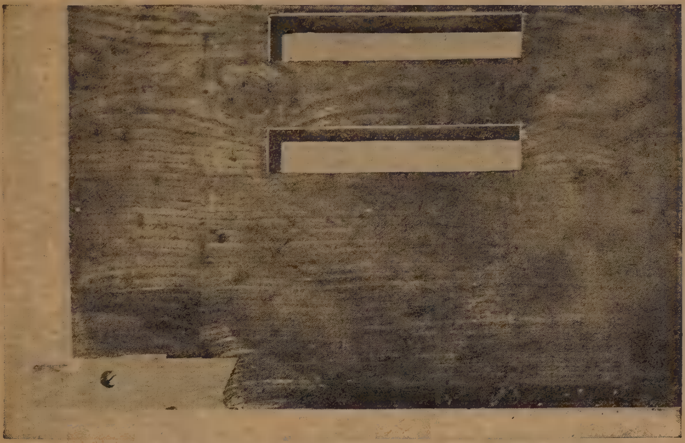


Fig. 18.—New Pin Piece Let into Corner of Block

quickly, the edges being placed and rubbed together to work out the surplus, then set in exact position and the straightening bits screwed up tight (see Fig. 12). It is then carefully lifted from the bench and stood aside in the same position in a dry, warm place to set overnight; then the other joint is made the same way.

The upper part of the pillar is broken at two of the corners, and the uneven surfaces are straightened with the chisel and bits glued in, as shown by Fig. 13, to be trimmed when set, as in Fig. 14. Fig. 18 shows how a new pin is put on the block. The bit of wood let in is 1 in. square, fixed with glue and two screws, the heads of which are sunk, to be covered with wood plugs. It is trimmed to the shape whilst in place.

The two damaged legs are next taken in hand. They are first tested by piercing with a bradawl to see if they are sound enough to be worth repairing, otherwise new legs would have to be made. Fortunately, it happens that they are fairly solid, except at the sides shown. The leg shown by Fig. 4 is repaired by planing off the lower damaged corner to the shape of a chamfer and gluing a new piece on by "rub-jointing." Another little bit is put on at the upper corner at the toe.

The leg in Fig. 5 has to have $\frac{3}{16}$ in. planed off the whole surface of the damaged side and be faced up with new wood glued and cramped on, as shown in Fig. 15, which also shows the other leg repair in the rough. When set, they are trimmed to the correct shape (see Fig. 16). The block is next put back in place on the pillar, the mortise holes, tenons and shoulders being well glued and wedged. The legs also are glued back in place, slips

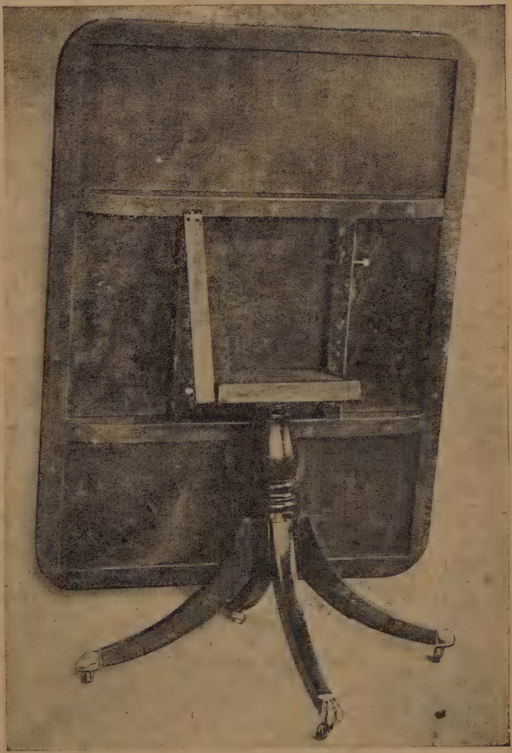


Fig. 19.—Finished Table with Top Fixed in Position

of veneer being inserted at the sides of the dovetails to tighten them, and the irons are screwed back as before.

The top joints, being now thoroughly set, may be cleaned off on the underside and the framing screwed back in place, and also the clamping pieces, which require refitting and gluing and screwing. It is necessary to put the framing on to pull the top straight before putting on the clamp pieces; but one long and one short rail must be taken off to put the top on. So in order to make the top easily detachable from the stand at any time, a little invention is introduced. It is a dovetail wedge piece cut out of the rail at the pin hole, as shown in Fig. 17, and when the top is on it is replaced and secured with a 2-in. screw. Fig. 17 also shows the thumb-screw through the rail, to fit a screw-plate at the front corner of the block, and another one is put opposite on the other short rail, these being required to fix the top when in use. It is often a convenience to be able to tilt the top up instead of removing it; and here another fault in the construction of the table presents itself. It should tilt enough to remain up, but the edge coming in contact with the leg prevents this. Another little invention overcomes the trouble. It is a rib of wood 2 in. by 1 in. in section, hinged at one end to the framing, with a hole at the other end through which to fix it to the block by one of the thumb-screws shown in Fig. 19. When the top is down for use (see Fig. 20), this prop is kept up against the frame by a hook and eye. (These two photographs were taken after the table was finished.) The table is cleaned up with scraper and glass-paper, and stained with vandyke brown made into a paste with liquor ammoniæ and thinned with water. When quite dry it is smoothed with fine glass-paper and rubbed over with linseed oil.

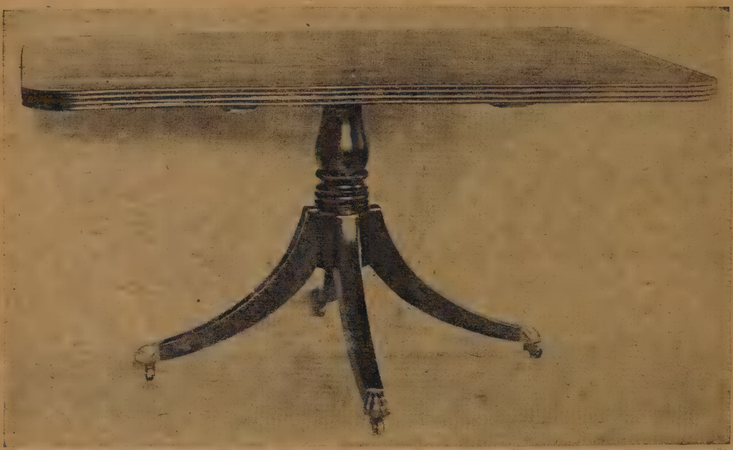


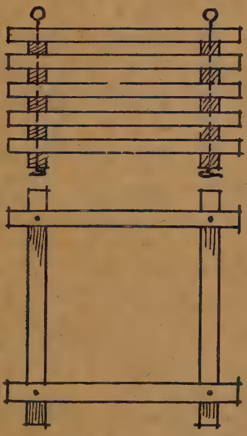
Fig. 20.—The Finished Table

A paste grain-filler is made by mixing whitening, coloured with umber, with turps into a stiff paste, adding a little linseed oil to act as a binder. This is rubbed well into the grain of the wood and forced into the worm-holes. After being left for about an hour the surplus paste is rubbed off with clean rags, rubbing chiefly across the grain. It must be cleaned off very particularly, and to do this a piece of worn glass-paper is used as a help with the rags.

After a few hours' rest, the table is french-polished in the usual way, using ordinary brown polish only. A good body of polish needs to be put on. Towards the end of the work half polish and half spirit is used. When finished, the work has a bright new look about it which is not desirable, so, after a couple of weeks' rest, it is slightly dulled by rubbing with fine pumice-powder. A piece of wadding is made into a pad, rolled into the powder, and put into a cover of old soft calico. It is pounced over the work, powdering it lightly with the white dust, and is rubbed with a circular motion until the right degree of dullness is reached, finishing off with a soft, dry rag. This gives the appearance of an old piece of furniture in a state of good preservation. The casters, renovated and lacquered, are put on with brass screws.

Square Hanging Baskets

Anyone having on hand a number of short lengths of small pieces of wood, either rough or planed, can easily convert them into attractive hanging baskets on similar lines to the one illustrated on this page. The size varies from a miniature composed of sticks of ordinary firewood to quite substantial receptacles, 12 in. or more square. Once the size has been settled, the procedure is simply to cut a sufficient number of equal lengths (twenty are used in the example shown), and arrange these in pairs which cross one another in the manner of an Oxford frame (see Fig. 2), with their ends projecting for about 1 in. Small holes are bored through the corners, and the sticks are threaded on copper or galvanised-iron wire, which is bent at the bottom to form a stop, and curved into a ring at the top to take a length of chain, wire, etc., by means of which each corner is connected to a central ring and hook at the top. There will be no difficulty in fitting a bottom to the basket, either with small strips of wood at intervals or stout wire crossing from side to side.



Figs. 1 and 2.—Elevation and Plan of Basket

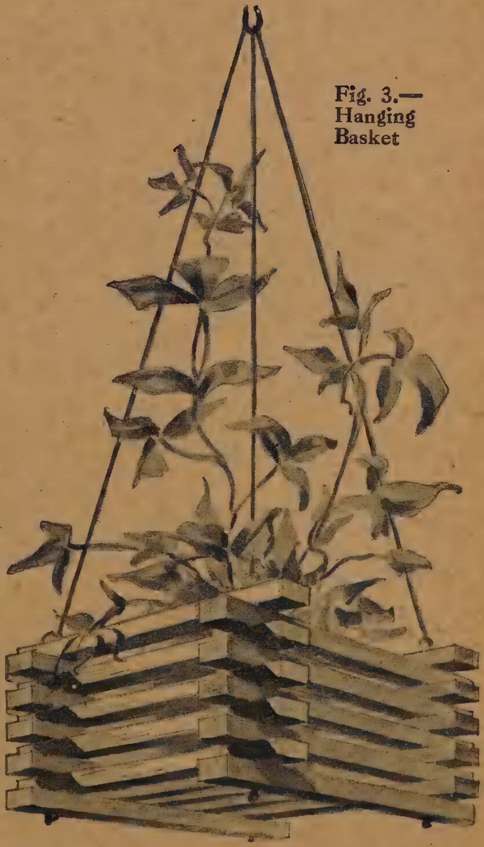


Fig. 3.—Hanging Basket

Making a Child's Folding Car

The illustrations show a child's car that can be closed into a space 14 in. wide, and carried like an ordinary camp stool (see particularly Figs. 1 and 2). This dimension could be reduced still farther by having the handles straighter and using smaller wheels. It is, however, not advisable to have the wheels too small, as this causes excessive wear and vibration, with its attendant noise. Probably wheels 10 in. and 6 in. in diameter respectively should be the smallest used.

The best material for the car is chair-maker's birch. The wheels and axles should be purchased ready-made with $\frac{5}{8}$-in. tyres, as the stock length of the axles will in a measure decide the width of the car. The members of the frame are $1\frac{1}{2}$ in. wide by 1 in. thick (see Fig. 3), and the principal dimensions are indicated in Fig. 4.

It will be advantageous to make a full-size working drawing to Fig. 4, before cutting up the timber, as then a better idea will be formed of economical cutting. The long piece, which constitutes the handles and front leg, could be cut with only a slight curvature, and afterwards bent to shape by steaming it and then binding it with cord to the edge of a board previously shaped to the required curves. The remainder of the woodwork presents no special difficulty. The rails for the back and seat are stub-tenoned to their respective members, glued, and pinned with brass wire. The length of the slots in the two pieces that support the arms and foot-board may be found by scribing through the holes for the supporting pins (Fig. 13) when the car is open, as Fig. 4, and again when it is closed, as Fig. 2.

Having fitted the woodwork together temporarily, put in the wheels and axles. Fig. 6 shows the front wheel free to revolve on a $\frac{1}{2}$-in. tubular axle, which butts against washers on each end, forming a distance piece for the legs. The tube is retained in position by a suitable rod, screwed at each end for nuts. Lateral motion of the wheel is prevented by the small collar, which is sweated on, and thin tin washers may be inserted next the collar from time to time, as wear occurs. An alternative method is shown in Fig. 7. The end that goes through the wood is reduced, and the shoulder so formed butts against a washer which prevents the axle being drawn through the wood when the outside nuts are tightened up. This axle cannot be taken out if the frame is riveted up as shown at Fig. 8, but by using bolts like Fig. 9 the frame can be taken apart.

Rear axles are usually square, and Figs. 10 and 11 give respectively a section and front view showing a simple method of fixing the axle. The wood may be left large at this point to counteract the weakening effect of the notch for the axle. In Fig. 12 the axle is passed through the centre of the legs, and a $\frac{1}{4}$-in. stay-rod keeps the legs tight against the collars on the axle. A loose collar made from gas tubing retains the wheel in its working position against the D-washer and split pin.

Finally, the seat may be of carpet or canvas covered with plush or any similar material, and the back may be treated similar to the upholstering on household furniture.

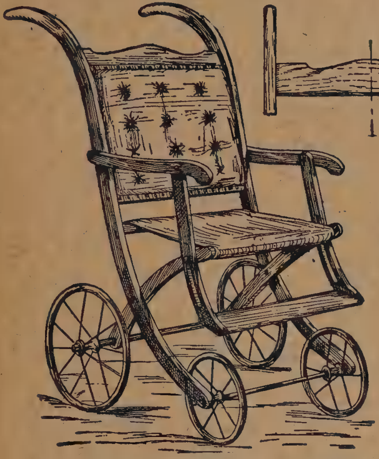


Fig. 1.—Child's Folding Car Ready for Use

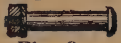
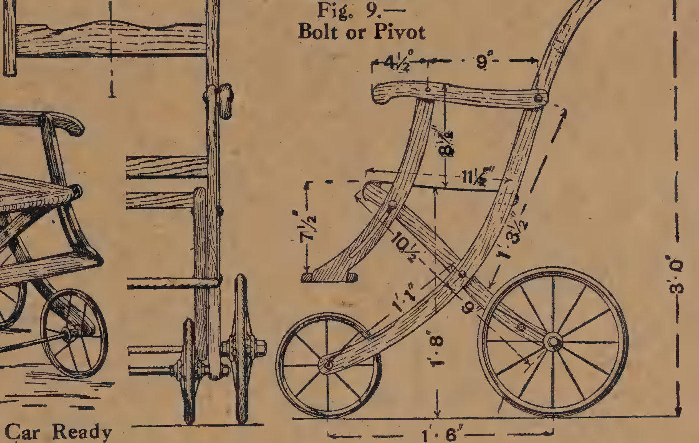


Fig. 9.—Bolt or Pivot



Figs. 3 and 4.—Two Elevations of Car, Open

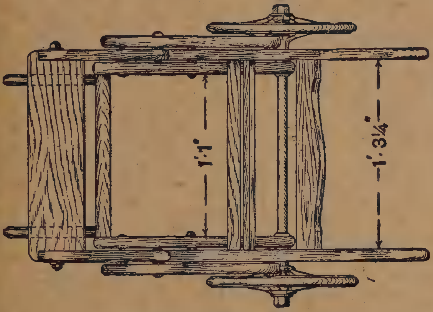


Fig. 5.—Plan of Car

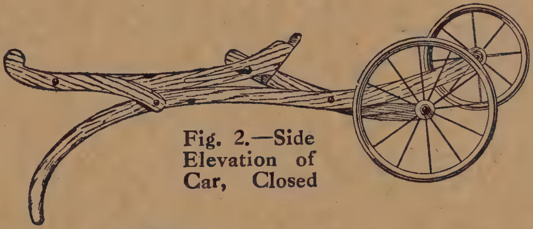


Fig. 2.—Side Elevation of Car, Closed

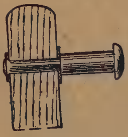


Fig. 13.—Pin for Slot

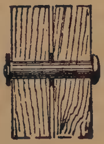


Fig. 8.—Bolt or Pivot in Place

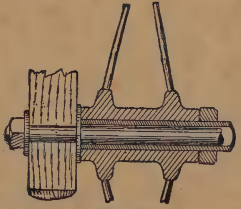


Fig. 6

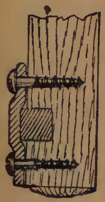


Fig. 10

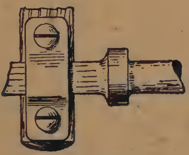


Fig. 11

Figs. 10 and 11.—Fixing Square-section Axle

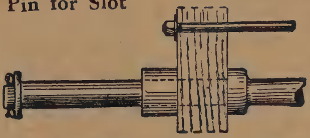


Fig. 12.—Alternative Method of Fixing Rear Axle

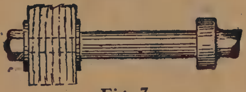


Fig. 7

Figs. 6 and 7.—Forms of Front-wheel Axle

Watch Cleaning and Repairing

The Requisite Outfit. — A tool and material outfit, even though a small one, is essential to the work of watch cleaning and repairing. For the renewal of watch parts, either a pair of turns (see Figs. 13 and 14), or a watch lathe, of which a variety is available (see Figs. 7 and 15), must be obtained. The turns, in which the work is rotated by means of a bow, cost about 10s., and the lathe anything from 15s. to £10. The watch cleaner's outfit need not cost more than about £1, which amount will easily include the few tools used in executing simple repairs. Certainly nothing can be done without at least an oil-pot, tweezers, pliers, pin-vice, sliding tongs, a few punches, a watch hammer, two or three files, two screwdrivers (ordinary and jewel size), pegs, pith, a watch brush, a small parallel bench vice, and an eyeglass (see Figs. 1 to 21).

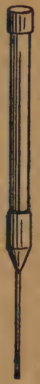


Fig. 1.— Watch Oiler

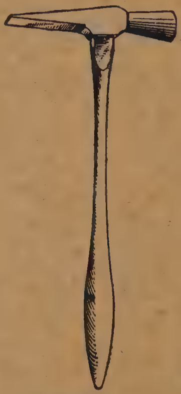


Fig. 2.— Watch Hammer

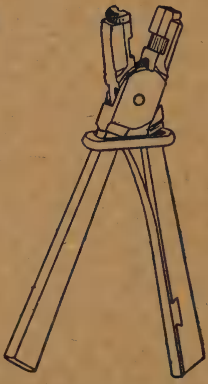


Fig. 3.— Dog-nose Sliding Tongs

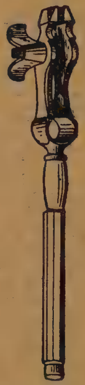


Fig. 4.— Dog-nose Pin-vice

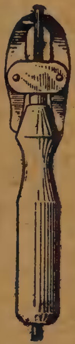


Fig. 5.— Lowell Hand Vice

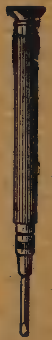


Fig. 6.— Watch Screwdriver

Tweezers are the ordinary watchmaker's tweezers; Boley hollow ones are useful.

Sliding tongs and other special tools used by watchmakers can all be purchased from the material dealers. All the tools necessary are illustrated in this chapter. Watch pegs are thin round sticks of

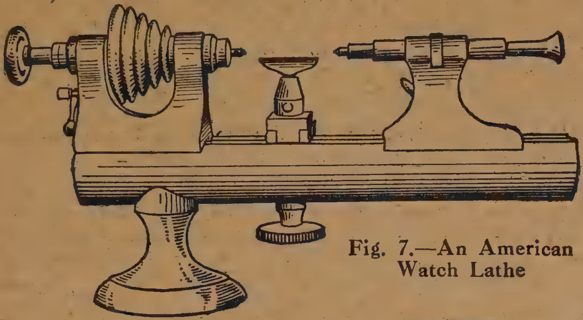


Fig. 7.—An American Watch Lathe

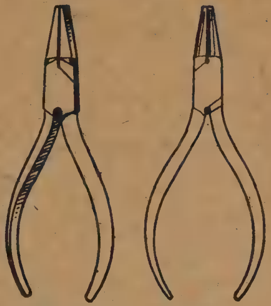


Fig. 10 Fig. 11

Figs. 10 and 11. — Square-nose and Round-nose Pliers

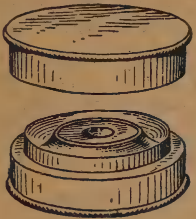


Fig. 8.—Oil-pot or Oil-cup

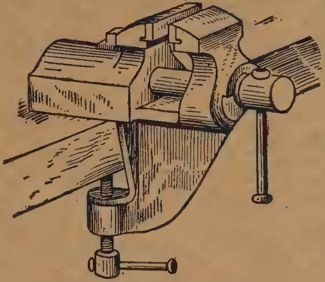


Fig. 9.—Parallel Bench Vice

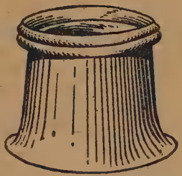


Fig. 12.—Eyeglass

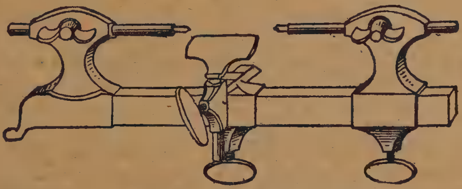


Fig. 13.—English-pattern Turns

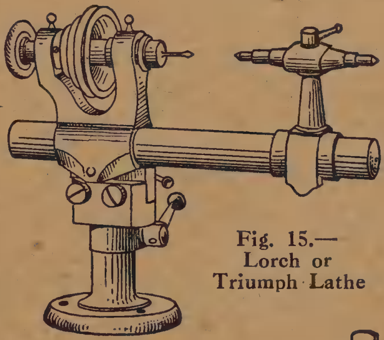


Fig. 15.—Lorch or Triumph Lathe

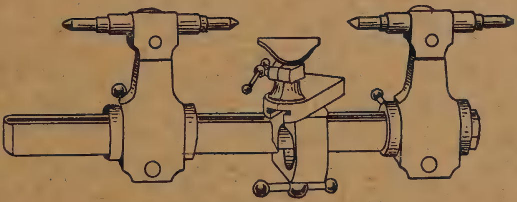


Fig. 14.—Boley-pattern Turns

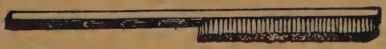


Fig. 16.—Watch Brush

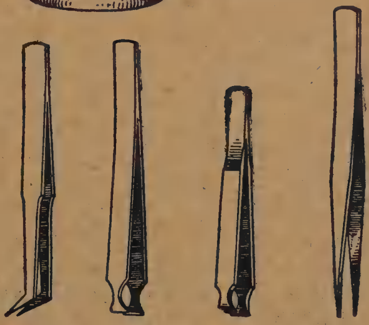


Fig. 18 Fig. 19 Fig. 20 Fig. 21

Figs. 18 to 21.—Tweezers of Various Patterns

Fig. 17.—Watch File

dog wood, purchased in bundles at the material shop. Pith for cleaning is also obtainable in the same way.

Petrol is the ordinary petrol as used for motors; benzine, benzoline, and petroleum naphtha are practically identical.

Watch oil is lubricating oil especially prepared for watches, and none other should be used. It is sold in small bottles, and is used by placing a drop in an oil-pot (a small cup with a cover, made for the purpose), and applied by an oiler (Fig. 1). This is a piece of thin brass or steel wire, with a blade hammered thin like a little spade or a drill blade, but thinner. It is provided with some sort of a handle, which may be of brass or pegwood, or simply sealing-wax. To use it, touch its blade with oil from the oil-pot, and apply it to the pivot. Used like this, one drop of oil put in the pot will oil several watches. The oiler is also used to place the oil in the pot. Dip it deeply into the oil bottle, and transfer a complete drop to the pot. Then cork up the bottle carefully again, and keep in the dark. In this way the oil in the bottle is neither soiled nor affected by light.

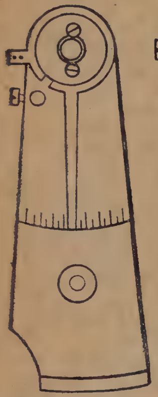


Fig. 22.—Balance Cock

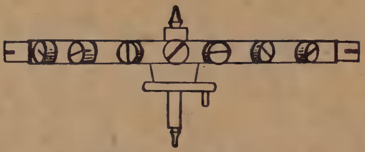


Fig. 23.—Balance

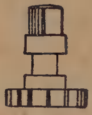


Fig. 24.—Cannon Pinion

CLEANING KEY-WOUND WALTHAM WATCH

A typical watch in general use is the full-plate key-wound Waltham. There are hundreds of thousands of such watches in use in Great Britain, and of the type they represent there must be several millions in use throughout the world; but, of course, they are now being superseded by the keyless watch.

Removing Movement from Case.—The first thing to do is take the watch, or rather its mechanism or "movement," out of the case. In this type of watch the movement is held in the case by two dog screws at the edge of the back plate. Having turned these, the movement can be pushed out from the back of the case. It will be noticed that, near to the two o'clock, there is a small pin in the edge of the movement, which fits into a hole in the case edge and keeps the movement in position when the dog screws are tightened. Having taken the movement out, it will be seen to consist of a brass frame containing the barrel and train wheels. On the front of it is the dial and on the back, held by the balance cock (Fig. 22), is the balance (Fig. 23).

The Balance.—This, together with its hairspring, is really the most important part of the watch; the timekeeping depends on it, and it serves the same purpose as the pendulum of the clock. When set vibrating, or revolving backwards and forwards under the influence of its hairspring, it will move quite regularly, whether it is turning only a quarter of a turn each way or a turn and a half. As a matter of fact, there is in most watches an extremely small difference between the times of the long and short vibrations, but this may be ignored for the present. The consequence of this equality in time of the vibrations of the balance is that, provided the mechanism of the watch is in fair order and capable of keeping the balance vibrating, the watch is sure to keep fairly good time, provided the balance and hairspring are themselves in perfect order. If the balance or spring is faulty, then the best possible mechanism in the rest of the watch will fail to make it go well.

The essential points of a good balance are as follow: It must be in perfect poise—that is to say, its rim must have no heavy part, but balanced exactly, so that no matter in what position the watch is held, the balance will act the same. Then it must have fine and smooth pivots, working in well-fitting and smooth jewel holes and the ends of the pivots must rest on smooth endstones. The balance itself must revolve quite freely, not being nipped by the presence of the endstones on the pivots, but having just the least trifle of lift or endshake to ensure absolute freedom. The balance must not touch anything as it revolves, or its freedom of motion will be impaired. For instance, the balance cross-arm sometimes touches the outer coils of the hairspring, and in such a case it cannot possibly keep time. The hairspring must be flat and true in its coils, not wobbling as the balance turns ; and it must not touch anything.

So the first thing to look at, on taking the watch out of its case, is the balance and hairspring. Give it a spin, and see if it revolves truly. Hold the watch up to the light, and look at the pivots sidewise as the balance revolves. If they are bent, a wobbling will be discernible. Try the endshake with the points of a pair of fine tweezers, lifting the balance rim and letting it fall again to see what lift it has. When doing this, do not look at the rim, as that may be bent, and so be deceptive, but watch the roller or the top pivot. Then the exact amount of lift can be seen. If the balance seems true and free, look at its spring carefully. If that is also free, and seems perfect, the balance cock (Fig. 22) may be removed, together with the attached balance and spring, and passed as in fair order.

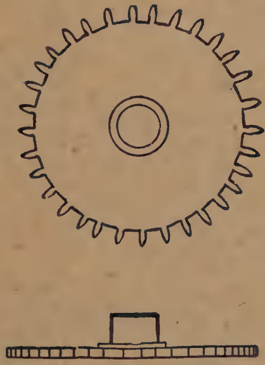


Fig. 25.—Hour Wheel

The Hands and Dial.—Turn next to the hands and dial. The minute hand should be firm, and move stiffly when the hands are set. If it moves easily, it may drag as the watch goes and lag behind, making it appear that the watch loses, whereas the watch may be keeping perfect time all the while. The hour hand should be free—that is, it must have just a little lift, or endshake, under the minute hand, and a little sideplay between the teeth of the hour wheel which carries it. The seconds hand must be quite free, and not touch the dial at any point. Sometimes a seconds hand is free in one position, and just touches the dial in another, so see it make a complete revolution before passing it as correct. If the hands seem all right, take them off. Cutting nippers will remove them one by one.

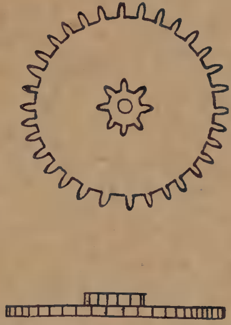


Fig. 26.—Minute Wheel

The dial feet pass through holes in the bottom plate of the watch frame, or "pillar plate," and are nipped tight by a small screw to each in the edge of the plate. Undo these dial screws a turn or two—they need not be taken right out—and the dial can be raised by the finger nail and removed. The underside of the movement can then be inspected. The hour wheel (Fig. 25) is lifted off, and then the minute wheel (Fig. 26). The cannon pinion (see Fig. 24, p. 66) carries the minute hand on its square, and must be tight on the centre arbor on which it fits, turning stiffly. To remove it, grasp its square by cutting nippers and pull it off with a twisting motion.

Barrel and Mainspring.—Attention must next be directed to the barrel and mainspring (Fig. 27). Put a key on the winding square, and see if the watch is wound up or has quite run down. If wound up, and it has stopped, it is proof that somewhere in the train wheels there is resistance of motion, which may be dirt between the teeth of the wheels, or dried up oil or rust on the pivots, causing them to stick in their holes, or a bent tooth in a wheel, or a bent pivot. A search and examination should be made to locate the fault before taking the watch apart. See, by trying each wheel in succession, where the power fails. Then try the endshake and freedom of each wheel. In this way the fault may be discovered, and, when the watch is taken to pieces, the particular part may be closely examined. If the mainspring is not quite run down, place the key on the winding square and press the click A (Fig. 28) out of action, and let the spring unwind itself in the barrel gently. Then unscrew the barrel bar (Fig. 29), and, having taken off the cap (Fig. 30) and ratchet B (Fig. 28), the barrel can be lifted out of the frame.

Removing the Lever.—The top plate of the frame is held by three pillar screws. These having been removed, raise the plate a little—very gently indeed—and lift out the lever (Fig. 31). If the plate is simply lifted straight up, the lever will catch, and its bottom pivot will be broken off. So proceed very gently in this operation. The lever being safely out, the plate may be removed and the wheels lifted out.

Cleaning Plates and Wheels.—Roughly dust off the loose dirt and old oil from the wheels and pivots, and, with the eyeglass, examine them to see if the pivots are straight and smooth, and that there are no bent or broken teeth. Fig. 32 shows the escape wheel, Fig. 33 the fourth or seconds wheel, Fig. 34 the third wheel, and Fig. 35 the centre wheel.

Put the plates and wheels, leaving out the balance and barrel, into a glass jar with a cover containing a little petrol, just enough to cover the parts. Remember that petrol is explosive, and keep it far from any naked flame. After a moment's immersion they may be taken out one by one, dabbed dry on a duster, and brushed clean and polished by a soft, dry watch brush charged with a little chalk dust. Just lightly rubbing the brush on a white billiard chalk will be sufficient. While brushing, the parts should be held in tissue paper to prevent their being soiled with the fingers.

After brushing, sharpen a watch peg to a fine point and peg out the pivot holes clean. Repeat this operation until the peg point is not soiled, showing that the holes are quite clean inside.

Cleaning Jewel Hole and Endstone.—Fig. 36 shows a jewel hole and endstone such as the lower balance pivot runs in. To clean such a hole, it is not sufficient to merely peg it out. The two little jewel screws must be removed, and the hole and endpiece pushed out from the inside with a watch peg cut flat. Then the endpiece is rubbed with the finger-tip on a piece of washleather and the jewel hole rubbed and pegged. Both are then replaced. To get the endpiece back level with the plate, push it in with a flat cut peg. If very tight, cut a peg carefully flat and make it into a kind of wooden punch, and give a tap with the watch hammer to force the setting into its place.

Reassembling Plates and Wheels.—This part of the watch can then be put together. Hold the pillar plate in tissue paper and place in position the centre wheel, fourth wheel, third wheel, and escape wheel, in the order named. Before putting in the centre wheel, oil its lower pivot. Then put on the plate loosely. Take the lever between the points of the tweezers and introduce it between the plates until its bottom pivot is in place. Then, with extreme care, apply a little pressure to the top plate, and with the tweezers place the wheels one by one in position, so that the top pivots go in their holes in the top plate and the plate drops down in position. Screw it on by the pillar screws and the lever, to see that all are placed in correctly.

Barrel and Mainspring.—The barrel and mainspring (Fig. 27) can now be taken in hand. The barrel cover or lid is snapped into an undercut groove round the inside top edge of the barrel. To get it off, insert a screwdriver blade under the hollow cut at one part of the cover, and prise it off. The steel arbor can be taken out, but the mainspring is best left in. The cover and arbor can be cleaned in petrol, and brushed dry and clean. The barrel and mainspring may be cleaned by screwing up a small piece of tissue-paper, and wiping out any old dirty oil from the coils and the bottom and inside. The hole is pegged clean. Then fresh oil is applied to the coils of the spring and to the pivots of the barrel arbor. The arbor may be replaced, and the cover snapped on again. In a Waltham watch there is only one place or position to place the cover, and that is so that the little nitch cut in the barrel cover just coincides with the steel pivot of the mainspring outer end.

Before replacing the barrel in the watch, hold the winding square in a pair of sliding-tongs, and wind up the spring to the top to make sure all is correct. Let the tongs slowly run back in the hand as the spring unwinds itself, and feel if there is any jerkiness or unevenness in the force. If there is, it is a proof that the coils of the mainspring bind against the barrel bottom or cover, probably because they are bent out of flat, or the spring may be too wide for the depth of the barrel to accommodate.

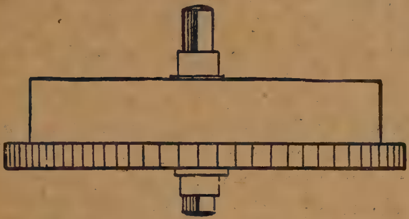


Fig. 27.—Barrel and Mainspring

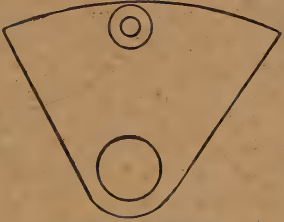


Fig. 30.—Cap

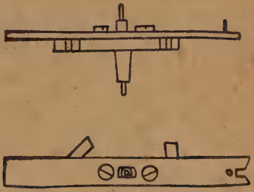


Fig. 31.—Elevation and Plan of Lever, showing the Pallets

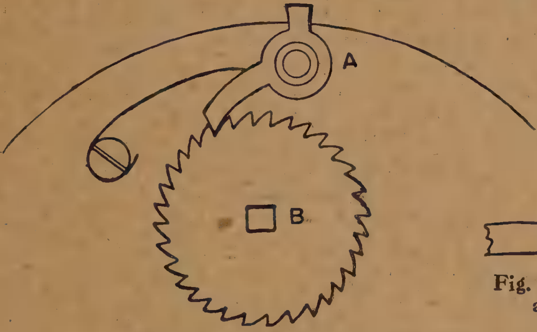


Fig. 28.—Ratchet and Click

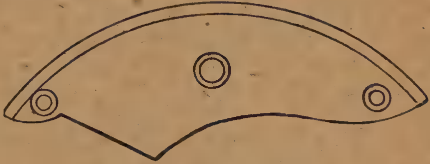


Fig. 29.—Barrel Bar

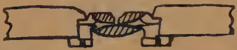


Fig. 36.—Jewel Hole and Endstone

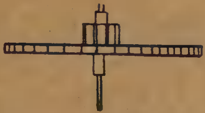


Fig. 33.—Fourth or Seconds Wheel

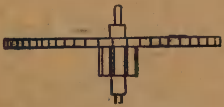


Fig. 34.—Third Wheel

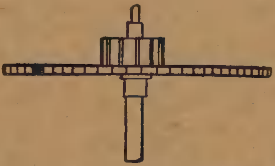


Fig. 35.—Centre Wheel

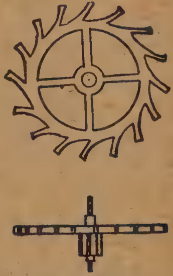


Fig. 32.—Escape Wheel

Presuming that all is correct, the pivots of the arbor that go in the frame plates may be oiled, the barrel replaced in the frame, the barrel bar (Fig. 29) screwed on again, and the ratchet and click (Fig. 28) and cover cap (Fig. 30) put on. A little oil is needed on the flat of the ratchet under the cover cap, and on the pivot on which the click works. Then the watch may be partly wound up and an inspection made. If all is correct, a touch on the lever will liberate an escape-wheel tooth, and an impulse will be given to the pallets, causing the lever to pass across to the opposite banking pin with a sharp click.

Cleaning Balance, Spring, and Balance Cock.—Of the going part of the watch, the balance, spring, and balance cock now only remain. Dip the balance and spring quickly into the petrol, and dab dry very gently, so as not to catch the coils of the hairspring on the bristles of the brush. A good way to brush clean the roller and lower part of the staff is to stick that part through a piece of tissue-paper. It can then be brushed vigorously and quite safely while the tissue covers up and protects the hairspring. The pivots are best cleaned finally with a piece of pith.

The balance cock may be dipped into the petrol and brushed dry and clean, afterwards removing the jewel hole and endstone for cleaning, as already described. Re-attach the hairspring stud by inserting it in its hole in the balance cock and tightening its set-screw. In doing so, see that the outer coil of the hairspring passes through the curb pins in the end of the regulator. Before doing this, a little oil must be applied to the top balance pivot hole. Now take the movement, and oil the lower balance pivot hole, and the top pivots of the centre, third, fourth, and escape wheels and lever. Then the balance and balance cock can be replaced in the watch and screwed down gently, great care being taken that the pivots are properly in their holes, and that the balance is not nipped tight. It is a good plan to keep the balance just in gentle motion while the cock is being screwed down, then if it is nipped or tightened up, a stoppage will instantly show it before damage is done.

The Lever.—The watch having been partly wound up, if all is correct, should go at once; but before proceeding farther, examine the lever. Hold the balance half a turn or so round on one side from its position of rest, and see if the lever has a little shake against its banking pin. Then let the balance go and hold it on the other side, and try the lever once more. If the lever is tight against the banking pip on one side, the watch will stop; so in such a case turn the banking pin round with a screwdriver (it is eccentric), and give the lever a little more room. There should be just a little shake, but not much. If too much, the watch does not go well, and the shake should be decreased.

Completing the Reassembling.—This attended to, oil the lower pivots of the third, fourth, and escape wheels and lever; the centre pivot should have been oiled before putting in place. Push on the cannon pinion (Fig. 24), the minute wheel (Fig. 26), and the hour wheel (Fig. 25), and replace the dial, screwing its feet tight. A little oil should be applied to the escape-wheel teeth. Then put the movement into its case again, and turn the dog screws, not forgetting the rim-cap that goes round the movement to keep out dust.

Finally, put on the hands. The hour hand goes on first, and must be free to move a little with the shake of the hour-wheel teeth in the minute pinion. It should also have just a little lift under the dial. If the hour wheel is nipped it will stop the watch. The seconds-hand pipe must not touch the sides of the hole in the dial, and the entire length of the hand must be just clear of the dial. The minute hand must push on quite tight and be perfectly firm, and move round rather stiffly when the hands are set.

The hands are not really a part of the going-mechanism, but they are a frequent cause of stoppages. They should never be hastily put on. The seconds hand must be watched all the way round to see that its point or its counterpoise does not touch the dial. The hour hand should be tested to see that it cannot possibly touch the seconds as it passes over the latter between five and seven o'clock. And the minute hand must be quite free of the hour-hand point beneath it, and of the glass above it. The centre square also must on no account touch the glass. This can be tested by oiling the top of the square and closing the glass, then opening the glass again and examining its surface. If the hour hand has so much play that it rocks about and cannot be prevented from catching either the seconds hand or the minute hand, the hands and dial must be taken off again and a paper washer, or two or even three, cut out and placed over the hour wheel under the dial to decrease the lift and hold it steady. They must not be thick enough to tighten it, but must still leave just a little play.

Cleaning the Case.—Before replacing the movement the case itself will need some attention. It is no use cleaning a watch and putting it back into a dirty case, for some loose dust from the case will very soon get into the watch and interfere with the working.

To clean the case, scour all the edges and snaps clean with a watch peg. Brush out the interior with a watch brush. Hitting the case band smartly with the brush-back will dislodge a great deal of dust. Push in the push piece, and hit the case again a few times to dislodge any dust behind the case spring. Then clean the case all over with an old watch brush charged with chalk powder and a few drops of ammonia and water (1 ammonia and 10 water). Next use a dry watch brush, polish up with a washleather, and wipe round the edges and joints.

If the push piece sticks, dirt may have accumulated round it and underneath it. Take out the bow screw and remove the push piece. Also take out the case spring. Then thoroughly clean out the hole in the case pendant and replace the parts. An astonishing amount of solid dirt can often be dislodged in this way.

FITTING NEW MAINSPRINGS TO KEY-WOUND WALTHAMS

Mainsprings for Waltham watches are sold ready to put in; that is, they are of the correct width and strength, and have the end piece or T-hook riveted on. To put one in, first thoroughly clean the barrel, arbor, and cover. Then begin at the outer end of the spring by inserting the T-hook into the small hole in the barrel bottom, coil in the spring ½ in. at a time with the fingers, pressing it well down as each turn is completed, until the centre is reached and all is in. If desired, a mainspring winder can be used, but take care that the T-hook does not cut the fingers and catch. Putting in by hand is the best method, and a very little practice enables this to be done quite safely without distortion. Care must be taken not to bend the spring as it is coiled in, but just to ease it as the coils are pressed home.

When the spring of a watch breaks it causes a great shock to the train wheels, the barrel "recoiling" sharply. This sometimes bends a barrel tooth, breaks a leaf out of the centre pinion, breaks a centre-wheel tooth, or breaks off a centre or third pivot. In a Waltham watch this damage is avoided by having the centre pinion screwed on to its arbor, as in Fig. 37. It is cut with a left-handed thread, so that the pressure of the mainspring tends to screw it tight; but should the spring break and the barrel recoil, instead of offering resistance and causing damage, the pinion simply becomes unscrewed. Therefore, when a broken mainspring is found in a Waltham watch, look to the centre pinion, as it will be found unscrewed, and screw it tight again, or it may be lost in brushing and cleaning the wheel.

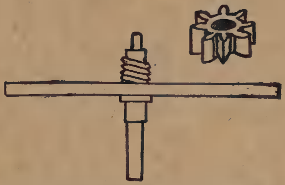


Fig. 37.—Central Pinion Screwed to Arbor

Riveting T-Hooks on Mainsprings.—If proper Waltham springs are not available, ordinary mainsprings may be used; one of the correct width and strength must be selected, broken off to the proper length, and a T-hook riveted on its end (see Fig. 38). The hooks can be bought very cheaply. To rivet one on, first soften the end of the spring by heating it in the flame of a spirit lamp or gas jet for about $\frac{1}{16}$ in. not more. Punch a small round hole near the end, and broach the hole out until the rivet on the hook just goes in. Smooth off both sides of the spring end with a fine file, and just take off the burr from each side of the hole by means of a countersunk or round chamfering tool, or a drill blade. Then rivet the hook on, and trim off its projecting ends, so that they are just long enough to hold properly in the barrel cover and bottom; but not so long that they project above or below the barrel when the watch is going. If these ends are allowed to project, they may stop the watch and badly score the parts with which they come in contact. The lower end, for instance, is apt to catch in the centre wheel, while the upper end will score the barrel bar or catch the balance.

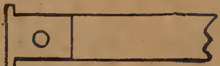


Fig. 38.—T-hook Riveted to End of Spring

BROKEN PIVOTS AND JEWEL HOLES

All parts of Waltham watches can be purchased ready to put in, the watches being wholly made by machinery on the interchangeable principle. But if a complete watch be purchased in little parts in this way, it would become expensive, and it is cheaper to put in new pivots in train wheels than to buy new pinions complete; still, for those who cannot put new pivots in nicely, the pinions are convenient. Jewel holes and endstones, on the contrary, are best bought. On no account pass a broken or cracked jewel; the watch is sure to suffer.

Putting in New Pivot.—To put in a new pivot requires the use of either a pair of turns or a watch lathe. The process is first to centre the pinion accurately; then drill a deep hole rather larger in diameter than the pivot. Take a piece of hardened and tempered steel like a needle or a piece of piano wire, and after tempering it to a blue colour, file it up in a pin-vice to a smooth gradual taper that will just enter the drilled hole. The steel is then worked in tight by hand, and cut off and filed flat on its end. The pinion is rested on a stake, and the plug driven in by a flat punch and a light tap or two until it is quite tight and firm. The pinion is then re-centred in the turns or lathe, and the plug turned down to form the new pivot. It is turned as smooth as possible with a sharp graver and polisher.

Polishing Pivots.—To polish a pivot in the turns, the pivot is rested on a groove in a brass or steel polishing bed, in which it revolves while a polisher is held flat upon it and moved to and fro after the manner of filing, but using very light pressure. The polisher is a flat strip of soft steel, and is moistened with oilstone dust and oil to smooth out the turning marks. When smooth, the pivot, polishing bed, and polisher are thoroughly cleaned and the surface of the polisher re-filed. Then red-stuff and oil is applied in the same way for a minute or two for the actual polishing, and should leave a surface like a mirror. In a watch lathe the pinion would be held in a split chuck, and the pivot could run unsupported while being polished.

The secret of pivot polishing is cleanliness and a perfect condition of polisher and polishing paste. Oilstone-dust and oil should be mixed on a stake—a box with a hard steel plate on which to mix, and a lid to keep out dust. It should be mixed thin. The polisher should have a slight grain on its surface, left from passing a fine file slanting across it. This grain serves to hold the polishing material. Red-stuff must be kept in a similar stake, but mixed rather thick and stiff. The polisher is re-filed and cleaned, and rubbed on the stake to just charge it with red-stuff and no more, very little being used. After the first wet has been rubbed down smooth and black, the pivot will be about half polished. Then clean off, recharge, and work down the second wet. This should be sufficient to complete the polish.

Drilling Pivots.—When drilling pivots a hard drill, untempered, must be used. It must be absolutely sharp, and lubricated with a small drop of turpentine, and as much pressure used as the drill will safely stand. It should at once begin to cut, and the metal cuttings should be seen accumulating round it in an ever-increasing heap. When drilled a little way —say half its depth—re-sharpen the drill and apply fresh turpentine. It is a great mistake to go on until the drill becomes blunted and ceases to cut, as it then burnishes the bottom of the hole glass-hard, so that it cannot be made to cut again. It is much better to re-sharpen once or twice while the drill still cuts.

It is generally best to finish a new pivot a trifle larger in diameter than the old one, then the pivot hole can be opened out with a broach to fit it. Most pivot holes get worn a trifle oval, and broaching will make them round again, and start the new pivot in a good, well-fitting round hole. Fig. 39 shows the various stages in the making of a new pivot.

The above directions refer to train-wheel pivots. When balance-staff pivots break, it is best to fit a new staff complete by buying one ready made and riveting the balance on to it. Those who are quite expert with the watch lathe can put in balance pivots if they like; there is no objection to doing so, and it is cheaper.

Fitting New Balance Staff.—To fit a new balance staff (see Fig. 40), the roller and hairspring must be removed from the old one. To remove a roller, hold it by brass-lined pliers so as not to mark its edge. If too tight to be moved thus, a "roller-removing tool" may be used. It may here be remarked that ingenious tool-makers have designed special tools for almost every operation in watchwork; but the good workman can do without nearly all of them, and to buy them all would fill a large tool cabinet and empty a deep pocket. The hairspring collet can be carefully prised off with a thin and sharp pocket-knife blade. Then put the staff with balance on in the turns or the lathe, and turn off the riveted part of the balance-staff face. Lay the balance on a stake, and with a flat punch drive the staff out at one blow.

If the new staff is correct, the balance will just push on to the seating, and the steel can be riveted over all round just a little by using a crescent-shaped punch (a round punch with a hole in its centre, half filed away). Do not hammer hard, or the balance may be sprung out of flat. Stop as soon as the balance is tight.

After either fitting a new staff or a new pivot the balance should be tested for poise, and a little taken off a screw-head to restore the balance where necessary. If it is much out, place a timing washer under a screw-head where the rim is light, as well as reducing one where it is heavy. The weight of the balance will then not be seriously decreased.

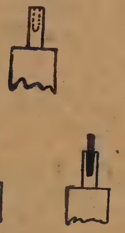


Fig. 39. — Stages in Making a New Pivot

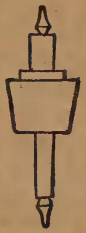


Fig. 40.—Balance Staff

If a hairspring collet is too easy on the new staff, it can be closed up a trifle with a pair of pliers without hurting the spring. If a roller is too easy on the staff, lay it on a flat steel stake, and take a smooth, round-face punch, place it over the staff hole in the centre, and give just one blow with the hammer. This depresses the edge of the hole equally all round, and is generally effective. If the roller will not go on high enough to be free of the lever, the solid portion of the staff must be turned back to allow the roller to go farther on. But the average new staff will be found to fit perfectly. Occasionally, one of the pivots will require reducing a trifle to come properly through its jewel hole and reach the endpiece. When this is the case, simply polish it with red-stuff, and in about a minute or so it will be sufficiently reduced.

BENT PIVOTS

Bent pivots either in the train wheels or the balance staff may be straightened by grasping the pivot in brass-lined pliers, as in Fig. 41. The shaded parts of the jaws of the pliers represent pieces of brass. Brass does not injure polished steel, and, strange to say, hard steel can be bent in this way with much less risk of breakage than if steel pliers were used. Any old pair of worn pliers may be made to serve this purpose, provided they are not too large and heavy. First soften them by heating nearly to a dull red. Then file out two recesses as in Fig. 41, and let in two pieces of thin sheet brass. Fix the brasses by soft soldering, and put a rivet in each. To use them, hold the pivot and the pliers up to the light, so that daylight can be seen between the jaws. Then the bending can be watched. To test a pivot for straightness, run the wheel in a pair of callipers.

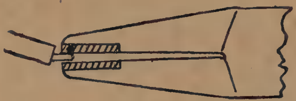


Fig. 41.—Straightening a Bent Pivot

BENT TEETH

Bent teeth in barrel or train wheels do not often occur in Waltham watches ; but they do occasionally. The blade of a pocket-knife is the best instrument to use. Fig. 42 shows a section of the little blade of a knife inserted between the teeth. A purchase is got against the firm root of the next tooth, while the blade is tilted over in the direction of the arrow to lift up the bent tooth.

NEW TOOTH

If a tooth breaks off during straightening, a new one must be fitted by filing a slot into the wheel rim, fitting a piece of brass wire filed square, and soft soldering it in. The best way to solder it is to lay the wheel with the wire in position on a piece of sheet brass, with a hole for the pinion or pivot to rest in, so that the wheel can lie flat. Apply a minute drop of acid to the parts, and lay on a microscopic fragment of solder. Then warm the brass gently over the flame of a spirit lamp until the solder flows into the joint. Immediately wash the wheel in water to remove the acid. Dry it and brush clean. Then cut off the wire to the correct length with cutting nippers, lay the wheel on a cork, and flat down on both sides level with the rest. first with a fine file, then with a No. 3/0 emery buff. Finally, shape up the new tooth, with a thin fine file, to match the rest.

WORN PIVOT HOLES

Pivot holes in the brass plates in time wear oval, and when a pivot runs dry and rusts, they rapidly wear large. Or, again, a repolished pivot is too small for its hole. In these cases the hole needs bushing. For this purpose bouchons are sold. They are little pieces of brass wire, with the ends turned true and a small central hole drilled. Select one, the hole in which will not quite go on the pivot. Just taper its end the least trifle with a fine file, and broach out the worn pivot hole from the inside of the plate, until the bouchon end can be forced half-way in. Then break it off, file the projecting end smooth and flat, and with a flat-faced punch drive it in level with the inside surface of the plate. Take a pivot broach, and open out the new hole to fit the pivot exactly. Always remember to use a broach with plenty of oil. In first-class work, the ends of the bouchon are faced off by turning in the faceplate, or mandrel, of a watch lathe ; but often a smooth flat-faced punch will drive a bush in as described above, and leave the inside surface quite smooth and flat enough. A drill blade just turned round in the fingers will remove the burr from the edge of the hole, and a round chamfering tool will clean off the outer end

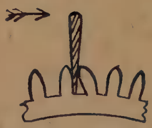


Fig. 42.—Straightening a Bent Tooth

of the bouchon level with the oil sink, and leave it smooth and polished. Do not file the inside end of the bouchon level with the plate; it marks and disfigures the plate badly.

In broaching a pivot hole, the plate must be held up to the light, and the broach kept at right angles to the plate; and when opened out to fit the pivot easily, the wheel must be put in the frame alone, and run to see if it spins freely and has correct endshake.

Sometimes a seconds pivot is worn very thin where it works in the plate, and is thicker farther up. In such a case, a long projecting bush is sometimes put in, so that it reaches the large and unworn part of the pivot. This will often save putting a new seconds pivot in, which is a more difficult job than an ordinary pivot, on account of having to be very firm, and because its length makes it slender and springy to turn.

DAMAGED HAIRSPRINGS

Straightening Hairsprings. — Hairsprings often get badly bent, and sometimes quite destroyed. Generally, this is through unskilful handling on the part of the workman, or through poking with a pin by the wearer in efforts to "make the watch go." Sometimes also they get rusty.

Bent hairsprings frequently look a hopeless tangle, but really, as often as not, have only one or two sharp bends, which, when found and corrected, will restore the spring to perfect shape again. To doctor such a spring, remove it from the balance and lay it on a watch glass in a good light. Wear the eyeglass, and with tweezers and a needle-point, begin at the eye of the spring where it leaves the collet, and run it round coil by coil until the first departure from truth is met with. Correct this by a judicious bend, and proceed to the next, and so on. In this way the outer end is reached finally, and the spring is got to shape again.

To flatten coils that do not lie flat, two pairs of tweezers are wanted, and a twist must be given to a coil to cant it up or down as required. Do not try to bend the spring edgewise.

Tangled Hairsprings.—A hairspring sometimes catches in the watch-brush, and gets simply tangled up without being really bent or damaged. If such a spring is not treated properly it will soon become damaged in the efforts made to correct it. Take the spring off the balance, lay it on a watch glass, and unpin it from its outer stud. Then hold the coils down with tweezers, and beginning at the centre, run a needle-point round and round the spiral until the end is reached, when the spring will be disentangled as if by magic. Re-pin in its stud, and all will be well again.

Similarly, if the hairspring is tangled round the balance rim, remove the collet from the balance, and unpin from the stud. Then run the spring round and round so that the balance rim travels outwards towards the outside coil. In this way the spring is, as it were, screwed off from the balance without damage.

Replacing Hairspring.—A rusty hairspring cannot be made right. It must be replaced. In the case of a Waltham watch a new hairspring can be purchased, ready pinned into its collet, and will only need putting on the balance. If preferred, an ordinary hairspring can be fitted to the old collet.

A Waltham, and nearly every other modern watch, beats 5 per second, or 150 double vibrations of the balance per minute. If a stock of hairsprings is kept, select one about the right outer diameter and lay it on the balance. Push the collet down tight on it to hold it. Then hold the outer end in the tweezers, so that the balance bottom pivot just touches a watch glass, and set it spinning, or vibrating, backwards and forwards. Have a watch with seconds hand on the board, and count the double vibrations of the balance under trial for 20 seconds. It should be 50; if more, the spring is too strong; if less, it is too weak. Proceed thus until a spring is found that, when held at the right coil to suit the index curb pins, counts correctly for a whole minute.

Remove it from the balance, lay it on a watch glass, and with the tweezers and a needle-point break out the centre coils until there is room for the collet. Bend the extreme inner end inwards for pinning in the collet. Place the collet on a broach tight, and hold in the left hand. Pass the spring over the broach and insert the end in the hole in the collet. File up a pin and flat one side of it to go against the spring, and pin it in tight. Lay it on the glass again, and set it true as nearly as can be seen. Place the collet on an arbor in the turns, and revolve it slowly to see if the spring runs true and flat. Bend the eye until it does so. Then pin it in its stud and try the watch. If it gains, let a little spring out or weight the balance a little. If it loses, take up a little more spring as far as possible, only to alter the balance when there is no more spring to let out, or when taking up more would spoil it. In no case alter the weight of the balance much, but rather fit another spring. For making slight additions to the weight of the balance, timing washers are sold to go under the screw-heads.

If the watch has a plain balance without screws, the spring alone can be altered to time it, and more care must be taken to count the vibrations per minute before pinning it in.

Correcting bent hairsprings and fitting new ones require great care, some practice and skill, and much patience. It is also a question of time, and cannot be hurried.

THE ESCAPEMENT OF THE WALTHAM WATCH

The escapement consists of the escape wheel, the lever and pallets, and the roller and balance staff. The escape wheel of a Waltham watch is of the club-tooth variety, so called to distinguish it from the straight pointed teeth of the escape wheel of an English lever. The pallets are "visible" pallets, as contrasted with the "covered" pallets of an English lever. Visible pallets have the advantage that a pallet stone is easily replaced, but the disadvantage that they are fragile. They often get broken or come loose, and to replace one requires some knowledge of the correct action of the escapement.

In Fig. 43 one escape wheel tooth is resting on the locking face of the entering or first pallet. If, now, the lever is moved a little away from the banking pin, this tooth will be liberated, and pass across the inclined impulse face of the pallet, giving an impulse to the lever, until it drops off the corner and another tooth falls on the locking face of the exit pallet. The important point to notice is that the teeth points fall on the locking faces of the pallets and not on the impulse faces. They should not fall far up the locking faces, but just safely past the corners, so that a very little movement of the lever will liberate them.

In these watches there are two holes in the bottom plate, through which the action of the teeth and pallets can be observed. It is no use observing them as the watch is going, for they move too fast. But the finger-tip should be placed on the balance rim and the balance led slowly round, and the action can be studied at leisure.

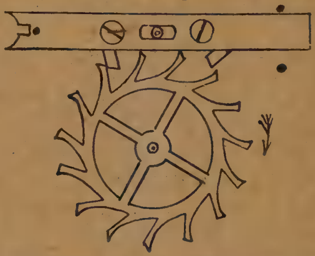


Fig. 43.—Escape Wheel with One Tooth on Locking Face of First Pallet

Re-cementing Pallet Stone.—To re-cement a pallet stone, the lever and pallets should be laid on a slip of sheet brass with a small hole in it for the top pivot to go through, so that the lever lies flat on the brass. Then lay a very small chip of shellac on the joint of the pallet stone and the metal of the pallets, and warm the brass plate gently until the shellac flows. Do not heat it until the shellac boils, but stop when it just gets liquid. Press the stone home in its slot, and hold it until the shellac sets. Then try the action in the watch, putting in the escape wheel, pallets, and balance only, to see if the teeth "lock" properly and give impulse correctly. If the stone is in too far the teeth will not lock, but will fall on the impulse face of the pallet. In such case, re-warm the pallets, draw out the stone a trifle, and try again.

The same process exactly is followed in repairing a broken pallet stone. The lever should not be separated from the pallets to warm them, as loosening the screws that hold them together will surely lead to trouble, especially for an amateur.

Cementing Broken Ruby Pin. — A broken ruby pin in the roller is cemented in with shellac in much the same way as the above. First clean out the hole in the roller, then place the roller on a tapered brass wire. Select a ruby pin that fits, and put it in the hole, warm the brass wire a little in a lamp flame, and touch the ruby pin with the corner of a flake of shellac. This will run at once, and may be worked in the hole by sliding the pin to and fro once or twice. While the shellac is still soft, hold the roller up to the light, set the ruby pin upright in both directions, and see that its flat side faces outwards truly. When cold, take a sharp graver and flake off the shellac that surrounds the pin, and any on the face or sides of the pin itself, or in the roller hollow or on its edge.

Testing Guard Pin or Safety Pin.— In the lever, just against the notch, is a little upright brass pin, known as the guard pin or safety pin. Its duty is to prevent the lever passing the roller edge except during the giving of impulse, when a little "passing hollow" allows it to pass. This "safety action," as it is called, should always be tested before passing a watch as correct. To test it, hold the balance half a turn round on one side, and with the tweezers see if the lever can be made to pass the roller. Of course, undue force will make it do so, but gentle pressure should not. See at the same time if it has any tendency to stick or jam against the roller edge. If it does so, it shows that it nearly passes. If this is the case, the guard pin should be bent forward a trifle until it is safe. After doing this, the banking shake should be tried on each side to see that it still has some. Not much is needed, but it must have some, or else the guard pin will constantly touch the roller edge and act as a brake.

Escapement Faults.—It sometimes happens that a watch, when cleaned, has a poor action. This generally indicates a fault in the escapement, especially if in some positions the action is better than in others. A bad action when the watch is on its face, with the balance uppermost, may be caused by any one of the following faults. The lever may touch the roller face. The lower endpiece may be cracked. The lower pivot may be bent or not come properly through its jewel hole. There may be something in the jewel hole itself. The balance may touch the top plate or the top of the barrel, or a hair or bristle from the brush may be sticking under a balance screw-head or in the plate somewhere and act as a brake. If the action is poor when on its back, the following faults may be present. The top pivot may be bent or short, or the top endstone be cracked. The hairspring may touch the balance arms or the balance cock. The balance arms may touch the hairspring stud or the index curb pins. The balance rim may touch the underside of the balance cock.

Some of the above faults are easily rectified. Excessive endshake causes some, and can be reduced by placing a small strip of tissue paper under the back of the balance cock and screwing down.

A bad action when the watch is hanging up, with the lever at the lowest point, indicates that the guard pin touches the roller, and the banking pins must be opened a little wider. Or that the ruby pin touches the bottom of the lever notch; in which case the pin must be warmed and set back a trifle. Or it may be caused by shellac on the ruby pin, or by cracked balance jewel holes.

To ascertain with certainty whether the fault lies in the balance pivots or jewel holes, or whether it is a faulty escapement, remove the roller and hairspring, and run the balance in its jewels to see if it spins quite freely in all positions. When it spins fast it will go over little faults; but watch it, especially as it stops. It should stop very gradually, and not suddenly with a jerk. See also if it stops always in one position. Careful observation will reveal the cause. If it runs badly on one pivot, examine that jewel hole and endpiece and pivot, and so on.

The successful watch repairer is the one who can locate little faults with ease and certainty. There is a purely mechanical cause for every vagary, and a search will reveal it. There are no mysteries. Some faults, indeed, are so small that they take a great deal of finding, but they are there to be found all the same.

De-magnetising Watches.—As a rule, it takes much more time to find the cause of the fault going than it does to rectify it when found, and when discovered it suggests its own remedy. Many watchmakers, when they cannot discover the cause of a stoppage or bad action, put it down to being "magnetised." This is a comfortable conclusion to come to, but it is not often the case.

A conclusive test of a magnetised watch is to place a small pocket compass, or "charm" compass, flat on the balance cock as the watch is going. If the compass needle remains fairly steady, the watch is not magnetised. But if it flies backwards and forwards, trembles violently, and generally behaves in an extraordinary manner, magnetism is present, and an electrician had better have it to demagnetise.

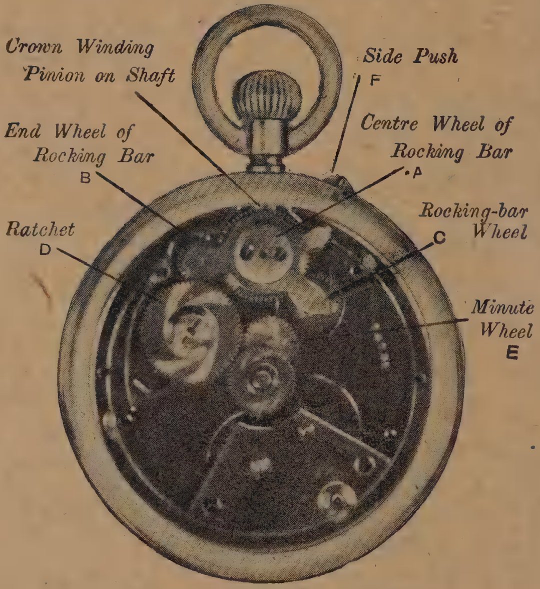


Fig. 44.—Rocking-bar Watch

A rough and ready way that sometimes succeeds is to tie a yard of string to the watch bow and twist it up. Then hold the watch suspended close to a powerful electro-magnet, such as a running dynamo. Allow the watch to spin round rapidly, roasting-jack fashion, and, as it does so, gradually withdraw it from the magnet until at a safe distance. Before treating a watch thus, it is as well to wedge the balance with tissue paper, so that it cannot turn round, or damage to pallets, ruby pin, or pivots may result.

REPAIRING AMERICAN KEYLESS WATCHES

American keyless watches are made in almost infinite variety, but there are in the main two general systems. the "rocking bar" and the "shifting sleeve." Fig. 44 shows a rocking-bar mechanism. The winding button is fixed to a winding shaft that passes through the neck of the case pendant, and on its inner end carries a crown-shaped pinion. This pinion drives the centre wheel A of the rocking bar. A, B, and C are all mounted on the rocking bar. Normally, a spring keeps B pressed against the ratchet D, which is fixed to the barrel arbor. Then, on turning the winding button to the right, the rocking-bar wheel B is naturally pressed well into D, and the watch winds. On reversing the motion of the winding button, the teeth of B slip past the teeth of D, and no action takes place. To set the hands, a side push F is forced in, and presses the rocking-bar wheel C into gear with the minute wheel E, and at the same time B is thrown out of gear with D. Then turning the button either way will set the hands.

This is perhaps the commonest form of rocking-bar mechanism, and variations of it will scarcely need description. The following points need attention:—The wheel B must engage well and deeply with the ratchet D. If not, the rocking bar must be given a little more movement, so that it may. A stop screw or other arrangement generally controls the movement of the rocking bar. Then the pinion on the winding shaft must engage deeply with the wheel A, or it will slip during winding. When the pinion is of the crown shape, as in Fig. 44, a thin washer behind it will keep the depth deeper. When it is a bevelled pinion, the only way to deepen the action is to keep the wheel A down close to it by reducing all play of the parts, leaving only freedom of motion. All rocking bars require well oiling, and must work quite freely, but have no play or "lift" from the plate.

Fig. 45 shows a shifting sleeve. The button, as before, is on the outer end of the winding shaft. The inner end is squared, and on it slides the shifting sleeve B. The ratchet teeth on B engage those on A, and while the spring C keeps B up to A, A is carried round by the winding shaft, and the watch is wound. When the side push E is forced in, the spring C carries the shifting sleeve B down the winding shaft until it is clear of A, and its lower teeth engage the motion wheels D, and the hands can be set. Fig. 46 is a detail of A and B.

Fig. 47 (a back view) shows the portion of the keyless winding work that is mounted on the barrel bar. It includes the main winding wheel C with which the winding pinion A (Fig. 45) engages, the ratchet D and click and click spring, etc. The third, fourth, and escape cocks have been removed to show the train wheels and escapement more clearly. The lever is of the "straight line" type, in which the balance lever, and escape-wheel pivots are all in a straight line. The dog screws that hold the movement in its case can be seen at K.

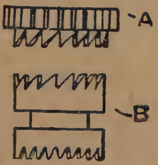


Fig. 46.—Details of Winding Pinion and Shifting Sleeve

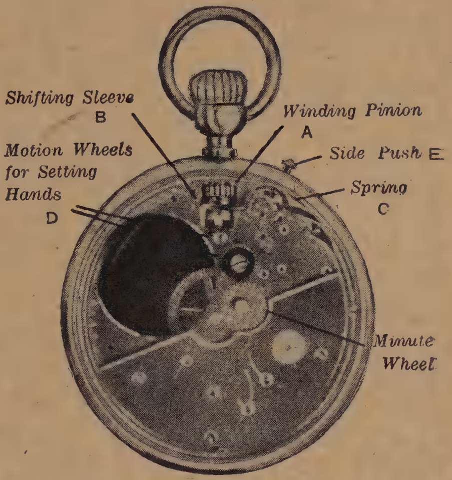


Fig. 45.—Shifting-sleeve Watch

In both these kinds of keyless work the side push is sometimes done away with, and a side lever used to throw the mechanism into gear for setting the hands; but, as a rule, this entails opening the case to pull out the setting lever. Another way of eliminating the side push is to cause the pendant or button to do all the work. Such are the "pendant-set" keyless watches, chiefly Swiss and American. Nearly all English keyless watches have rocking bars and side pushes.

In pendant-set watches, pulling the winding button sharply outwards throws the winding wheels out of gear and the hand-setting wheels into gear. This is effected in two principal ways. In the first all the mechanism is in the watch movement, and the winding shaft goes right into the watch, like that in Fig. 45. In the other the button is on a short-winding shaft, and is held by a spring clip in the neck of the case. These are usually found in American watches. When such watches give trouble in the winding, it is generally caused by a want of adjustment of this spring clip. If on pulling out the button the watch still winds and does not set the hands, the clip must be screwed outwards a little. A slot will be found in it for the insertion of a screwdriver blade. If the button when pushed in does not wind, but either sets the hands or does nothing at all, turn the clip inwards a little. A broken clip can only be replaced by a new one.

The keyless work of some American watches contains parts that are slender and difficult to make. When such parts break, new ones can be purchased ready to go in the watch. In Swiss watches it is not always so easy to obtain new parts, though generally something very near can be bought from a material dealer. But frequently the only course is to take a piece of sheet steel or steel rod, and, using the broken part as a pattern, file up a new part, harden and temper it, and finish it to fit and act nicely. Practice in filing and patience are the only requisites to make keyless parts. When a new part is roughly filed to shape, hold it by a piece of binding wire, and heat it to a bright red in a spirit-lamp flame and plunge into water or oil. Clean off and rub lightly on a fine emery buff to brighten one side, and try it with a file to see if it is properly hardened. If hard, the file will not cut it. If hardened properly, lay it on a slip of brass and heat over the lamp flame until its bright side turns a deep blue. Then finish it to exact size, and brighten and smooth it all over.

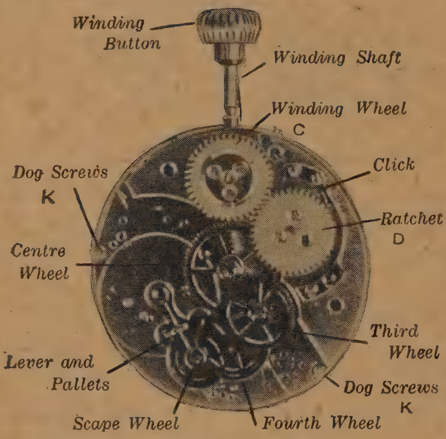


Fig. 47.—Back View of Shifting-sleeve Watch

When hardened, the part will be very brittle, and must be handled with care. Tempering to a blue takes off the extreme hardness and gives it elasticity. Blue-tempered steel requires a fine-cut file to file it, and may be smoothed nicely by laying it on a cork and applying a fine emery buff-stick—emery-paper on wood—say a 3/0 or 4/0 grade.

All keyless work where friction takes place requires oil on the flat sides of wheels, on shifting sleeves, winding shafts, and all points of contact of springs. All screws must fit well and be driven home, or they will work loose and cause damage.

The centre screw of a rocking bar, and sometimes the screw that holds the top winding wheel of a Swiss shifting-sleeve watch, is often left-handed, and requires turning to the right to withdraw it.

The button of an American watch with a spring clip in the case pendant is screwed on the winding shaft, and may be removed by holding the inner squared end of the shaft with the pliers, and unscrewing the button with the fingers. The buttons of Swiss shifting-sleeve watches are generally driven on a tapered square, and may be easily driven off when required. In making a new winding shaft to such a watch, it is as well to drive on the button tight and apply a little soft solder, washing off well in water afterwards and oiling it.

Removing Keyless Watches from Cases.—In the case of English watches loosen the dog screws at the back and push ; with foreign watches, first remove the winding button and stem, and sometimes the set hands push-piece as well. Sometimes the winding stem is fixed in the case pendant by a small set-screw, which must be first drawn out ; at other times, a set-screw on the back plate or bar of the watch movement needs to be turned. Failing a set-screw, there is generally a screw near the pendant in the watch plate. When the set hands push-piece requires to be taken out, a set-screw will be found just on the case edge underneath the bevel snap, or else on the watch plate opposite it. In addition, dog screws will be found as usual, and in some watches these are underneath the dial, when the hands and dial must be first removed. Some few watches must be taken half to pieces before it is possible to get them out of their case.

REPAIRING MODERN ENGLISH LEVERS

The modern English lever, whether keyless or key-wound, has a going barrel like a Waltham, and resembles that watch so closely that the directions for cleaning and repairing the one (consult the early pages of this chapter) apply almost equally well to the other. The main point of difference is that they are not so interchangeable in their parts, even when machine-made, and therefore there will be more hand work required in their repair. There are several small structural differences, and these will be pointed out.

The pallets are generally covered—that is, the steel portion is slotted, and stones cemented in and polished off level with the steel. Such pallets do not readily break, and hardly ever need any repair. But in some machine-made watches the pallets are made on the Waltham plan, visible, and may be treated exactly the same. A covered pallet-stone can be advanced to alter the depth by warming; but generally they are a little more difficult to handle.

The centre pinions of English watches are hardly ever screw pinions, but are solid; and consequently, when a mainspring breaks, damage often results to the teeth or pivots, especially barrel teeth. To replace a broken barrel tooth, a hole is drilled in the barrel edge and is tapped. A steel pin is screwed in quite tight, cut off to length, and filed up to the shape of the rest of the teeth.

The mainspring is often fastened at its outer end in a different manner. Instead of the T-piece the end of the spring may have a hole in it, and a hook is fixed inside the barrel to hold it. When the hook is a good one, this method is preferable to the T-end, as it strains the mainspring less, and causes fewer breakages. When a barrel hook gives way, the hole should be re-tapped and a new hook made from soft steel wire or very hard brass, and screwed in quite tight. The inside should not project much more than the thickness of the mainspring, and should be undercut to hold the spring close to the barrel. It is no use at all soft-soldering the old hook in again, as is sometimes done. It will pull out almost immediately.

Another feature sometimes found in English lever watches with going barrels is the dummy wheel between the barrel and centre pinion. The object of this was originally to make the watch wind to the left, in the same way as the older fusee watch with chain. Winding to the left was so distinctive a feature of the English lever, that it was at first hopeless to try to make buyers believe their watches were English if they wound to the right. Consequently, when the fusee was abandoned and the going barrel came into use, the extra wheel was inserted to fill up the emptiness of the frame plates and reverse the winding; it is still retained by some makers. In a few watches this idle wheel has been used as a safety device, and been arranged to throw out of gear upon breakage of the mainspring. It is then useful, but only a very few are so arranged.

REPAIRING FUSEE WATCHES

The above remarks refer to the key-wind full-plate going-barrel levers, mostly machine-made; but there are still some hand-made fusee watches about (see Figs. 48 and 49), and, owing to their good workmanship and hard material, they will continue in use for many more years, though their manufacture has practically ceased.

Fig. 50 shows the arrangement of the barrel, fusee, and chain. A is the fusee and B the barrel. The fusee is to equalise the power of the mainspring. When the spring is fully wound up it pulls strongly, and to counteract it the chain pulls on the small end of the fusee cone. When nearly run down, the spring is weak, and the chain pulls on the large end of the cone. Thus the pressure is on the centre pinion, and consequently the actual driving power of the watch remains constant throughout its daily run. It was thought that regular timekeeping depended on a constant driving force; but the modern lever escapement and pattern of hairspring are independent of such variations within large limits, and the absence of the fusee is not felt. On the other hand, its omission removes one cause of trouble—the chain—and greatly decreases the cost of the watch and the wear and tear.

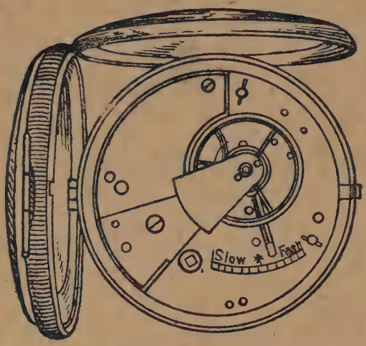


Fig. 48.—English Lever Full-plate Movement

Taking to Pieces.—A fusee English lever is taken to pieces and cleaned exactly as a going-barrel watch, except that precautions must be taken first of all to let down the mainspring. This is done by loosening the screw of the barrel click under the pillar plate, and, placing a key on the barrel arbor square, letting the spring unwind itself. Sometimes the square is so short that a key will not hold it. Then try a pair of cutting nippers, and let it down a few teeth at a time by means of the click. If the watch is fully wound up, and there is nothing at all to grasp, another method must be followed. One plan is to remove the barrel bar, and, placing the thumb on the top of the barrel, ease it back, so that the chain can be unhooked. Then let the barrel run back under the thumb. There are other ways, and some advocate one way and some another.

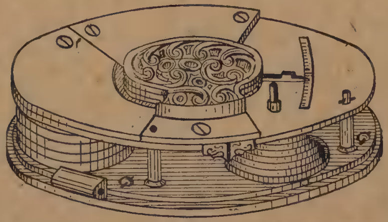


Fig. 49.—Fusee Watch with Verge Movement

In putting a fusee watch in the petrol for cleaning, the fusee should not be touched by petrol unless it is taken all to pieces, and it is not usual to take a fusee to pieces for cleaning unless there is something wrong with it.

Putting Together.—When putting the watch together, the chain is put on last, the method being as follows: Turn the fusee round with a key until the chain hook hole is outermost, and turn the barrel in the same way. Then hold the movement vertically, so that the chain may be dropped clean through from fusee to barrel. Place the barrel chain hook in its hole in the barrel, and put the thumb on it. With a key on the lower end of the barrel arbor, wind the chain up on the barrel, until the fusee end just reaches the hole in the fusee lower groove. With tweezers hook this in and, proceeding to turn the barrel, wind the chain tight. Hold it so while the barrel ratchet is put on. Then wind the arbor up another half-turn to set up the mainspring, and screw the click tight. The watch can then be wound up, seeing that the chain lies evenly on the barrel and goes straight to the fusee grooves, or it may run over their edges and damage them.

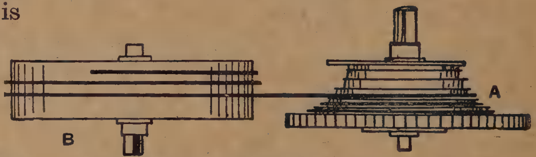


Fig. 50.—Barrel, Fusee, and Chain

Repairing Fusee Chains.—Chains and fusees are liable to many mishaps, and are a constant source of trouble. Chains break and hooks pull off. To mend a chain or put on a new hook, proceed as follows: Screw a block of boxwood in the bench vice, and lay the chain on it. Hold down the link with the finger nail, and insert a thin sharp pocket-knife blade between the links, and use it as a lever to raise the end link previous to removing the rivet. Do this just sufficiently to show the rivet end. Then fix a needle in a pin-vice, and slightly flat off its point. Place the chain on a steel stake with a row of graduated holes, so that the rivet is just over a small hole. Then with the pin-vice and needle press the rivet straight through. If it will not press out in this way, rest the needle on it, and give the pin-vice a tap with the watch hammer. Treat each broken end thus, and obtain a double link on one end and a single link on the other that match each other. Then temper the needle in the pin-vice to a blue colour, file it up thin and tapered, and insert it in the rivet holes of the chain, giving it a gentle tap in tight. Cut it off level on both sides, and, laying the chain on the boxwood, hold it by the finger nail flat while the rivet ends are filed level with the links. Do not leave them standing up. Then lay the chain on a steel stake, and tap it with the hammer to close the link, and rivet the ends a trifle on both sides.

Taking Fusee to Pieces.—The ratchet and clicks inside the fusee get out of order sometimes. When this is so, take the fusee to pieces. Hold it by its square in a pair of sliding tongs, and push out the copper pin through its lower part. All can then be taken apart. Sometimes cleaning away the dirt and filing up the ratchet teeth will make it right. But occasionally either the clicks or ratchet must be renewed.

The old ratchet can be removed by prising up with a pocket-knife or a screwdriver blade. It will be found pinned on by two brass pins. To fit a new ratchet, one must be selected that is of the right size, which can be judged by laying it on the steel maintaining ratchet, and seeing how it fills the space and goes up to the clicks. Then broach out its central hole to push tightly on to the fusee arbor flat down to the brass, the stumps of the old pins being flattened down level. Drill two holes through it as it lies, right down deep into the fusee brass. Fit brass pins, and drive them in tight. Cut them off level; then place the fusee in a chuck in the lathe, turn the pins off flush with the ratchet face, and cut out the centre of the ratchet around the arbor, so that the maintaining ratchet will lie close up to it. If no lathe is available, the turns may be used; but a special fusee-turning arbor will have to be purchased to hold the fusee.

Fitting New Clicks.—This is a troublesome little job. The old ones must be punched out from underneath. New ones are filed up from a length of click steel, which is steel drawn in a strip, just the section of the outline of a click. Fig. 51 shows how a click is made from it. The end of the click steel is filed back, leaving the pivot standing up as shown. Then the click is cut off by a slitting file where the line is drawn across. The pivot must be easy in the hole, but not shake about.

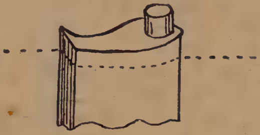


Fig. 51.—Making New Click

The click is fastened in by riveting the end of the pivot just enough to hold it in position, but not enough to tighten it. It is a tricky little job, and will need a fair amount of care and patience. Finally, the top surface of the click is flatted down level with a fine file, and the burr taken off its edges with a sharp graver.

Other Fusee Repairs.—Another little trouble is the pin on which the fusee end of the chain hooks; this sometimes breaks. To put in a new one, take the fusee to pieces, push out the old pin or its remains, and fit a nice brass pin in the old hole, filing it flat on both sides so as not to project.

The fusee grooves also are liable to damage. A thin burnisher may be used to raise the edges when they get pressed down; but the greatest care must be used or they will be spoiled.

Putting Fusee Together. — When putting a fusee together, oil the surfaces well that come into contact, and the clicks.

Pin it up finally with a copper pin, cut the pin off on each side with cutting nippers, and rivet the ends by pressing with the pliers. If the fusee winds too stiffly, it is pinned up too tightly, and can be eased by holding the main wheel teeth in the fingers, and giving the end of the bottom pivot a smart blow with the hammer. This beds the copper pin and eases it. If brass had been used for the pin, the fusee could not be eased in this manner; hence the use of copper.

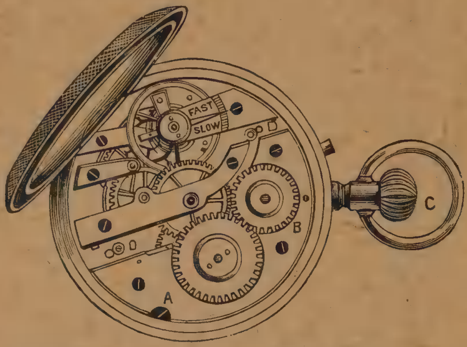


Fig. 52.—Geneva Watch with Bar Movement

The Stop.—The stop of a fusee watch is also liable to give trouble. See that it works freely, and its spring does not bind. Its end should be flat and true, not notched or rounded. If it fails, find out by observing whether the finger on the fusee passes above or below it. Then take the watch apart and adjust it accordingly, and try again.

REPAIRING SWISS BAR-MOVEMENT WATCHES

There are several distinct kinds of Swiss watches, including (1) the cheap full-plate levers which resemble Waltham watches in general arrangement, and for which the same directions for cleaning and repair apply; and (2) the more typical Geneva lever watches, made with bar movements (see Fig. 52), in which most of the wheels are held by separate cocks or bars, or at least in which the top-plate is subdivided. Sometimes the barrel and centre wheel are held by one portion and the rest of the train by another, and so on. These watches have several distinctive features that will be given attention in this chapter. Fig. 53 shows the three-quarter plate movement.

Taking Bar Movement out of Case.—First, it is necessary to turn the dog screw that will be found on the pillar-plate. Then the movement will push out from the back. The dials are generally held by two feet, each provided with a screw. This screw should be turned inwards until the hollow in its edge allows the dial foot to be withdrawn. Remember, that in putting the dial on again the screws must be drawn outwards, to make the dial feet tight. Having taken off the hands and dial, and removed the balance, the centre arbor A (Fig. 54) must be removed. This is arranged quite differently from the full-plate watches previously described. The centre pinion B of a Geneva watch is hollow; that is, it has a hole drilled right through it. The centre arbor, carrying the set-hand square, passes through this hole friction-tight, so that it can be turned to set the hands. The cannon pinion C is pushed tight on the arbor and does not move. To remove the arbor, hold the movement in the hand, and give a smart tap with a watch hammer to the projecting end of the arbor where the minute hand fits on. This will drive it through the cannon pinion.

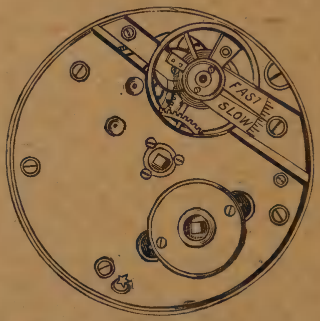


Fig. 53.—Geneva Watch with Three-quarter Plate

Tightening in Bar Pinions.—The arbor sometimes works too easily in the centre pinion and allows the hands to drag. To tighten it, a good plan is to rough it slightly by laying it on a fine sharp file and placing another file on the top of it. Roll it between them, applying some pressure. This impresses the teeth of the files on the steel evenly all over and tightens it. If too much, it can be smoothed with a burnisher again until easy enough.

If a cannon pinion is too loose on the arbor (it needs to be quite tight) it may be tightened by inserting a bristle from the watch brush in its centre and pushing on the arbor again. As it does not turn on the arbor, the bristle does not wear away. This method is better than hammering or burring the arbor, or squeezing up the cannon pinion.

Cleaning Barrel or Bar Movement.—The barrel in a Geneva bar movement is also made differently. The arbor and ratchet are in one piece, and the part of the barrel arbor to which the mainspring is hooked inside the barrel is screwed on to the arbor proper, holding the barrel and bar together. So to take such a barrel and bar to pieces for cleaning, first remove the stop-work, then the barrel cover, then the mainspring, and finally, holding the winding square in a key, grasp the centre piece of the arbor with pliers and unscrew it. In a few watches on this plan the inside arbor, instead of being screwed on, is pinned on by a steel pin going right through from side to side. There is often a difficulty in getting the pin out; but patience will generally be rewarded.

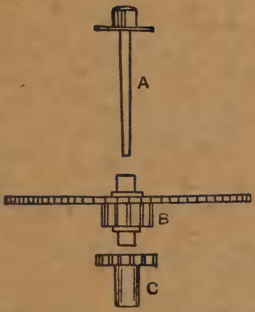


Fig. 54.—Centre Arbor, Centre Pinion, and Cannon Pinion of Geneva Watch

Escapements of Bar Watches.—These escapements are quite easy to take apart and put together again, each piece being held by a separate cock or bar. But in some watches made by dividing the top-plate, putting the centre wheel and barrel under one portion and the third, fourth, and escape wheel under another, trouble is often found in getting the top pivots in their holes. A very thin pair of tweezers is required to manipulate the wheels, and a light touch to keep a gentle pressure on the plate or bar while the pivots are being got in position. No force must be used. It is well when the third pivot is in to put in the nearest bar screw to hold the top plate, and then pay attention to the others. This prevents the first one getting out again while attempts are made to get the remainder in.

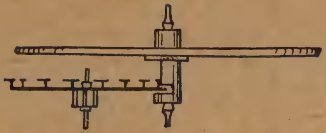


Fig. 55.—Cylinder and Escape-wheel of Cylinder Watch

REPAIRING CYLINDER OR "HORIZONTAL" MOVEMENTS

Thousands of cheap Swiss watches having cylinder or "horizontal" escapements are still made. The points to look to in these watches are the following: An inspection of the cylinder will show that, where the escape-wheel teeth act on it, it is cut away to half a circle (see Fig. 55). A little lower down it is further cut away to a quarter circle, by a slot or "passage," as it is termed. This slot is to accommodate the flat part of the arms of the escape teeth, while the impulse faces act on the upper past of the cylinder.

It is important that the flat part of the escape wheel should not touch either the top or bottom of this slot or passage. To prevent this, the endshakes of the escape wheel and cylinder must be carefully attended to, and reduced to quite a small amount.

If a cylinder watch is held to the ear while it is going, first dial-up, then dial-down, and the escape wheel touches, it can be heard to scrape, and the height of the cylinder altered slightly to correct it. The lower pivot of the cylinder is held in a "chariot" screwed to the pillar plate, and packing this a little will lower the cylinder a trifle; or, removing burrs, etc., will raise one. Or if the cylinder needs advancing towards the escape wheel to make the depth deeper, by bending the steady pins of the chariot it can be done.

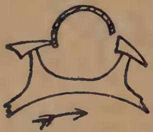


Fig. 56.—Correct Locking of Tooth

The depth just mentioned is a particular one. The points of the escape teeth must just lock. To test this, lead the balance rim round with a peg point and watch the escape wheel. The moment a tooth drops, reverse the balance. If the tooth has locked properly, the escape wheel will stand still for a moment before the next tooth unlocks and begins to advance. If it has not locked, the wheel advances immediately the balance is reversed. If they do not lock, the remedy is to advance the cylinder a little towards the escape wheel.

As in the lever escapement, the teeth must just lock, and that is all. If the wheel stands still long when the balance is reversed, it locks too much, and the cylinder must be got back a little. Fig. 56 shows a tooth just locked properly.

Cylinder Pivots.—These are formed by inserting plugs into the open ends of the cylinder, and turning the pivots on them. When a pivot breaks, the plug is knocked out by means of the special punch shown in Fig. 57. The cylinder body is rested on a stake over a hole through which the body will not quite pass. Then the plug is driven out by light taps. It sometimes happens that a plug cannot be moved. Then, in a watch lathe, the cylinder can be cemented on a chuck with shellac and truly centred, and the plug drilled and a pivot put in in the ordinary way.

Strengthening Cylinder for Turning.—Whenever a cylinder is put in the lathe or turns, the hairspring is removed, and the cylinder filled with shellac to strengthen it and prevent breakage. After operating on it, the shellac is boiled out in a spoon filled with spirit of wine and held for a little while over the flame of a lamp.

Banking Pin.—The little pin in the balance rim is the banking pin, and prevents the cylinder from turning too far round. It comes into contact with a fixed pin in the back of the balance cock. When the watch is exactly in beat, and the balance at rest, the pin in the balance rim should be exactly opposite to the fixed pin in the cock, so as to allow half a turn in each direction before it comes in contact.

Flattening Escape Wheel.—A frequent cause of trouble in these watches is an escape wheel that is not flat, causing some teeth to be free in the cylinder passage and some to scrape it. Place such a wheel in a pair of callipers and, holding a pointer against it, note the high or low part and bend the arms by a brass punch until it is true. This is a delicate operation. The wheel should be laid on wood, with the pinion through a hole to accommodate it, and a rounded brass punch placed on the arm to be raised. A tap in its centre will raise the rim at that part by bowing the arm downwards, and thus throwing the end up.

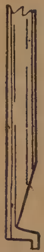


Fig. 57.—Punch for Removing Cylinder Pivot Plugs

How to Make Artificial Marble

Scagliola.—This kind of artificial marble can be made in situ or in the workshop. The atmosphere should be dry and warm, and provision should be made for protecting the work from dust. The plaster-of-paris (not Keene's cement) should be of the purest, hardest, and finest quality, and every precaution should be taken to guard against the introduction of metallic dust or unsifted coarse grains of inferior plaster, which would show in dark colours during the polishing. Glue size is used in order to harden the work and assist the polishing, and also for retarding the setting so that the worker may have time to manipulate the colouring.

The glue size is made by dissolving 1 lb. of best Scotch glue in 7 qt. of water, and sufficient size water is used with each gauge to retard the setting by about six hours. The mixing is best done on a perfectly clean slab, which may be of slate, glass, or marble. Experience is the chief factor in obtaining the best results, which is also the case as regards the cutting into slices and the colouring. No dry colours are used, only ground water-colours, which should be kept in covered jars in the form of a paste, so that a portion may be taken out with a palette knife as required.

With 1 pt. of size water gauge a portion of plaster rather stiff, and then add to it about 9 oz. of light purple-brown, also mix 2 oz. of black with 1 gill of size water; work these colours into the plaster with the hands and roll out, cut into slices 1 in. thick, and separate into pieces the size of walnuts, placing them at a distance apart on the bench. The veining in this case should be white, and a few crumbs of the uncoloured plaster should be scattered over these lumps, as also a few bits of alabaster. Brush these lumps over with uncoloured plaster fresh gauged in a basin, using a dash brush.

Knead the mass into one big lump, and cut with a knife into three slices, repeating the operation three times, after which the mass may be cut into slices ¼ in. thick and applied to the desired surface and allowed to set. The surface is now planed with a toothed iron (Fig. 1, next page), and polished with grit-stones and water until the surface is true. The glut is cleaned off with a sponge and the work left to dry. The surface holes can be stopped with the same kind of plaster that was used for the slab. A steel scraper with turned edges, on the principle of a woodworker's scraper, is used for smoothing the work, which is alternately scraped and polished with grit-stones until the desired surface is obtained. When the work is moulded, stones cut to the required shape are used for scouring the moulding. This stopping and stoning process must not be repeated until the previous stopping has set, and usually from one to five days are required to complete the polishing.

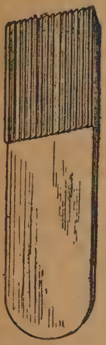


Fig. 1.—Toothed Planing-iron

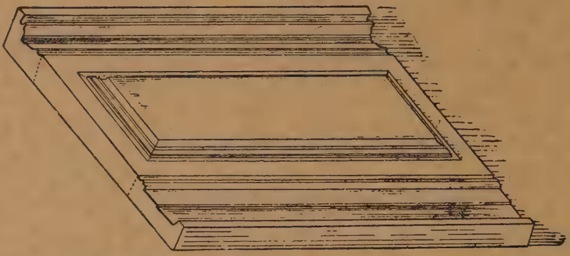


Fig. 2.—Dado, Plinth, and Panel Mouldings

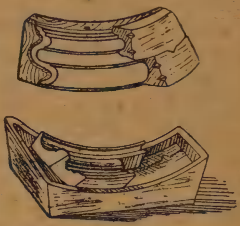
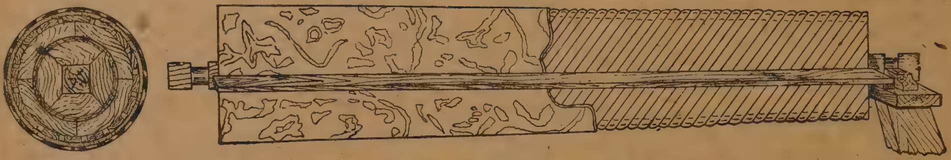


Fig. 3.—Base of Column

Polishing the Scagliola. — Before proceeding to polish with raw linseed oil and putty powder, the work should be thoroughly dry and hard, because any contained damp will work out and spoil the polish, except, of course, where the work is hollow and the ventilation is good, when the damp may escape through the back. For the polishing process tripoli polishing stone (a kind of chalk of a yellowish-grey colour) is used, as also water-of-Ayr stone; next a rubber of felt dipped in putty powder; finishing with linseed oil, which dries quickly and makes the hardest surface. If these processes are carefully carried out the polish will surpass that of real marble.

Making Columns.—The method that is described above is substantially the same for all processes, with only slight variation of detail as required by the design. In making columns, etc., a framework is constructed and lathed with substantial laths, and then coated with strong sized haired stuff, and scratched over the entire surface in order to provide a key for the scagliola (Figs. 4 and 5). The scagliola is then coated on the back and also on the scratched surface, and slightly beaten into position with a mallet, the whole being allowed to set in preparation for planing.



Figs. 4 and 5.—Column Built of Laths and Scagliola

Mouldings.—Scagliola mouldings such as dado and plinth (Fig. 2) may be cast by running a plaster reverse mould, shellacking and greasing it. The scagliola when sliced is placed in the moulds, firmly embedding a framework of lath by which the scagliola is fixed. Plain slabs of scagliola may be fixed to the wall direct either by plugs or to a floating coat of strong gauged haired plaster applied to the brick surface. Cast and turned work should be supported by strong wooden frames, with ribs or brackets, and covered with $\frac{1}{4}$-in. to $\frac{1}{2}$-in. sawn laths (Fig. 3).

Various Colours. — Following are a few methods of preparing scagliola of various colours: For Penzance marble, take 9 oz. of light purple-brown to 1 pt. of size water; veining (plain mixing), 2 oz. of black to 1 gill; for rich mixing, 5 oz. of black to $\frac{1}{2}$ pt., and 1 oz. of black to $\frac{1}{2}$ gill. For sienna, take 5 oz. of sienna to $\frac{1}{2}$ pt. of size water for dark shade; 3 oz. sienna to $\frac{1}{2}$ pt. for middle shade, and 2 oz. of sienna to $\frac{1}{2}$ pt. for a light shade. For griotte marble, take 10 oz. of light purple-brown to 1 pt. of size water, 5 oz. of dark purple-brown to $\frac{1}{2}$ pt., with alabaster spots and crumbs with a little black. Veining black should be mixed very stiff. For Egyptian green, take 5 oz. of black to 1 pt. of size water; for light shade of veining, ½ oz. of green to ½ pt., also ¼ oz. of green to ½ gill. These veinings are, of course, mixed separately. Now mix white in the same proportion as the veining, and mix a handful of black plaster crumbs with the white; chop the black lump and the white and black crumb lump three times, knocking together three times, and then cut into slices and apply to the framework, whether of dado, pedestal, or pilaster, etc. For brown belge, four shades are required, one of light purple-brown, two of middle shades of blue-black, and one very dark shade of vegetable black; veining, burnt sienna with red alabaster spot. For light shade, 4 oz. to ½ pt. of size water; 4 oz. of middle to ½ pt.; 4 oz. of very dark to ½ pt.; ½ oz. of burnt sienna to ¼ pt.; ¼ oz. of black to ¼ pt.; ½ pt. for the grey, with crumbs and red alabaster spots. Of the many different kinds of marble for which there are recipes for the imitation, only five are given.

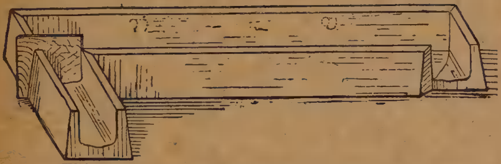


Fig. 6.—Mould for Curb

Marezzo Marble.—Keene's cement used with the same colours as are used for scagliola makes a good imitation marble, but not so good as scagliola. It may be cast from glass, wood, or plaster moulds (Fig. 6). While scagliola has depth and is translucent, marezzo generally gives the impression of a painted surface.

Moulding a Marezzo Curb.—Curbs for fireplaces and jambs and mantles, risers and treads, and many other objects, are easily made in marezzo. The Keene's cement must be of the best; no size is used, and the mould may be filled up with a backing of Keene's cement and sand 2 and 1, thus enabling a truly solid cast to be made (Fig. 7).

Take, for example, the making of a curb of, say, St. Ann's marble. The mould having been run and seasoned by applying linseed oil or prepared by shellacking and greasing, gauge one bowl of Keene's cement of the consistency of cream, and divide this quantity into four parts, putting each into a clean bowl. In the first bowl, mix a small portion of black, making the mass a blackish grey; make the contents of the second bowl twice as dark, and the third bowl merely tinted with a little of the first, leaving the fourth bowl white. With a small camel-hair brush charged with the white, paint in the veins (veining should be copied from an actual specimen); or, better still, dip some threads into the white, hold an end in each hand, and with a zig-zag or twisted motion drop the thread on to the face of the mould; do the same with the third bowl (that is, the slightly tinted one), striking the veins at different angles. Now, with the brush or the finger-tips charged from the second bowl, drop or splash the tint all over the face with such force as will slightly alter the course of the veining; do the same with the first bowl, and so on, alternately, until the surface is entirely covered. A trowel-shaped small tool should be lightly passed over the surface so as to give greater cohesion.

The setting of the Keene's cement should be somewhat hastened by absorbing the moisture or any water that may have accumulated. For this purpose a piece of coarse scrim is cut to the length, but a little wider, and placed in the mould; this is now covered with dry Keene's cement, which is left for a minute or two until the facework, by the absorption of the dry cement, is fairly stiff, when it may be gently lifted out and placed on

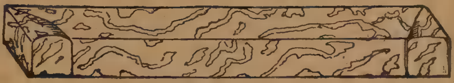


Fig. 7.—The Curb as Cast

one side to be mixed with sand as a backing.

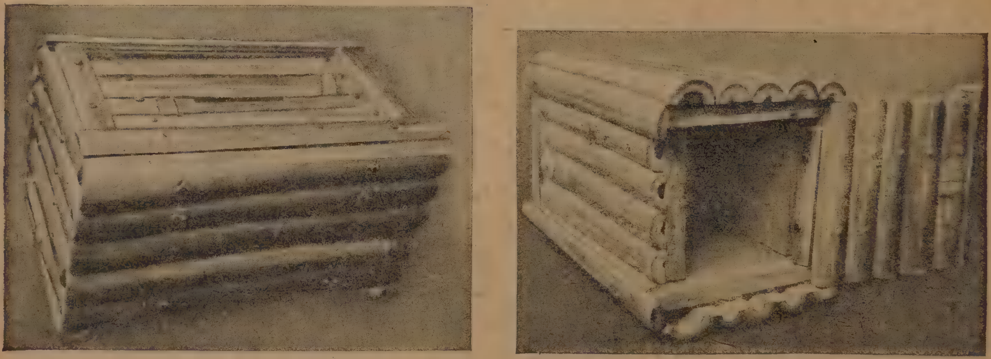
In order that the cast may be easily knocked out, a painted iron rod $\frac{1}{4}$ in. thick is provided, and two or three zinc or wire loops; the rod is embedded in the centre, the loops are brought underneath and left protruding through the backing so that the fingers may get a firm grip, and the cast lifted while an assistant gently taps the edges of the mould.

For filling out the mould with coarse stuff, take sufficient Keene's cement with gritty sand in the proportion of 2 of sand to 1 of cement, and gauge fairly stiff and apply with a gauging trowel, taking care not to disturb the veining, and when the mould is half full place the rod in position and cover up until level with the edges of the mould. If any coloured Keene's cement is left it may, with advantage, be spread over the back. This is then left until the next day, when the cast may be taken out; the entire surface is then gone over with a scraper in order to remove any grease or scum, after which the stopping is done, using the same colours, and leaving it to set for another day, when it may be gone over with the scraper again, and so on, until the stopping process is completed.

When dry the polishing may be done with felt pads dipped in linseed oil in the same way as scagliola is polished, and when finished the loops are cut off.

A Bamboo Money-box

The illustrations show a simple method of ornamenting ordinary wooden boxes of almost any kind, by nailing all over them halved strips of bamboo. In the present case, a small box with a sliding lid at one end was converted into a money-box. The bamboos are first split in half and the edges smoothed with file and glass-paper. Pieces of the necessary length are then cut with a fine saw, and holes are made with a pointed bradawl for the small wire nails, taking care to avoid splitting. For the edges, quartered strips are prepared. The pieces are then all tried in position on the box to find the best arrangement as regards fit, and are laid on the bench in an easily recognised order. The nailing is now done gently. Fig. 1 shows the box closed, while in Fig. 2 the open lid gives a good idea of how this part should be contrived so that the method of opening is invisible.



Figs. 1 and 2.—Bamboo Money-box, Closed and Open

Repairing Spectacles

A WELL-MADE spectacle frame is a masterpiece of lightness, elasticity, and strength; yet breakages will occur. Repairs to frames fall under two headings. First, there are actual breakages of parts that cannot be replaced and necessitate brazing or hard soldering together again. Second, there are breakages of details that are best got over by supplying new parts.

Straightening Bent Frame.—First consider the case of a bent frame that requires straightening up properly. Figs. 1, 2, and 3 show different views of a spectacle frame: A represents the sides, B the joints, C the eye wires, and D the bridge. Dealing first with the frame shown in Fig. 1, see that when viewed in this position the eye wires C are in a straight line with each other, and not, for instance, like the dotted line E. This can be lined up with two pairs of pliers, operating on the elbow of the bridge next the eye wire that is out of line. The joints B should be of an equal angle, and not like the dotted line shown at one joint. If not correct, hold the frame (with lens in) firmly in the hand, grasp the defective joint with a pair of pliers, and forcibly bend it to match the other one. Finally, see that the sides A are symmetrical, and not as shown at F. Bend them with the fingers until correct.

Next view the frame as shown in Fig. 2. See that a straight line drawn through the joints runs through the centres of the eyes. The bridge attachments are not necessarily on this line, but they sometimes are. Bending the bridge itself will correct the alignment of the joints and eye wires. Lastly, look at the frame as shown in Fig. 3. The eye wires should be level with one another, and not as shown by the dotted line G, and the sides must both be upright and angled equally, and not as at H. To correct the level of the eye wires, take the frame in the hands (lenses in), and twist it bodily. To correct the angle of the sides, hold the frame by the eye wire next the defective joint in the fingers grasp the joint in a pair of pliers, and twist it until the side lines with the other one.

When all these points have been attended to, finally hold up the frame in all three positions in succession, and see that everything lines up properly, as in altering one detail others may have been disturbed.

Hard-soldering Broken Frames.—There are three principal points where the main part of a spectacle frame breaks. These are shown by Figs. 4, 5, and 6, the breaks being at A. Take a break like Fig. 4, where the eye wire has parted at the joint. To repair such a breakage, remove the lens, unscrew the joint, and remove the side. Then thoroughly cleanse the parts of grease by washing and brushing with benzine or petrol, scrape the parts to be united quite bright, and place the joint together again. Do not screw the joint together, but bind it round with fine iron wire to hold it together. If the screw is put in, the heat will fix it so that it cannot be removed. When the two parts of the joint have been securely bound together, bend the eye wire so that its broken end just springs together properly in position. Now it must be brazed.

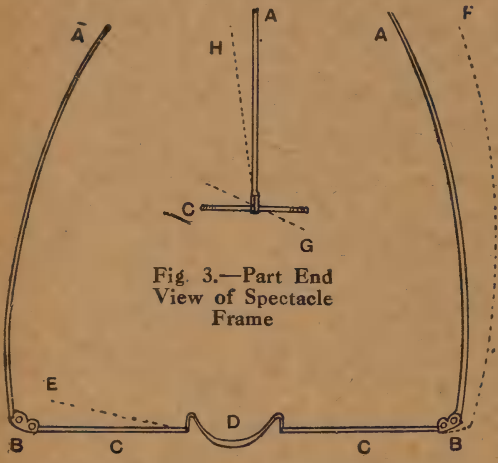


Fig. 3.—Part End View of Spectacle Frame

Fig. 1.—Side View of Spectacle Frame

The brazing solder will differ according to the material of the frame; a steel frame may be united with brass spelter or silver solder, spelter making the strongest joint. A solid nickel frame or a rolled-gold frame should be brazed with silver solder. A common gold frame should also be joined with silver solder. A 12-carat or finer gold frame may have low-quality gold solder.

Obtain a lump of borax, and rub it down with a few drops of water on a small piece of slate until a paste is formed. Take a little of this up on the point of a knife blade, and apply it to the surfaces to be united. Scrape the solder bright on both sides, and cut off a small piece; dip this in the borax paste, and lay it on the joint. Then hold the frame in the hand, and direct a blow-pipe flame to it. First heat the joint, as that is the thickest, then lead the heat to the join, and raise both parts to be united equally to a bright red heat, when the solder should flow. In steel frames great care must be taken to direct the hottest part of the flame to the steel, and keep it there. Do not remove the flame before the solder runs, or it will oxidise and not run. The hottest part of a blow-pipe flame is just where the blue ends. If one part is heated more than the other, the solder will only run on the hottest. If the parts do not actually touch each other the solder will not unite them; and if not all absolutely clean to start with, the solder will not run. If from any cause a steel frame does not solder, it is no use applying more borax, adding fresh solder, and blowing hot again; continuing this course will only burn up the frame. Begin again, scrape and file all clean and bright, and go through the whole process again more carefully.

Nickel and rolled-gold frames generally are easy to solder, and good joints are made. Low-quality gold frames are the most difficult, as the gold so easily melts. With such a frame blow very gently, and be very careful to heat equally, and stop the moment the solder flows and glistens.

When soldered, unbind the joint, screw it up with its proper screw, and clean it up. If steel, clean with fine emery cloth and emery buffs say $\frac{2}{0}$ or $\frac{3}{0}$ fineness.

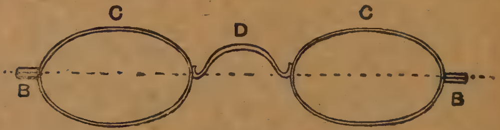


Fig. 2.—Front View of Spectacle Frame

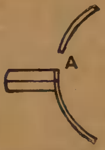


Fig. 4.—Broken Joint in Spectacle

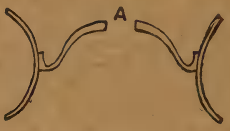


Fig. 5.—Spectacle Broken at Bridge Centre

The blue can be restored, if desired, by carefully heating over a spirit-lamp flame; but some practice is required to heat evenly and produce a good blue. A nickel frame may be cleaned with the emery cloth, and burnished bright with a steel burnisher. A rolled-gold or a gold frame should have the heated parts dipped in sulphuric acid (1 acid, 10 water), then rinsed and buffed up with a leather buff and rouge, and finally burnished. After this process the lens should fit as before; but if not, a touch on a wet grindstone is all that is necessary.

When a bridge is broken in the centre as shown in Fig. 5, or at the join with the eye wire, as shown in Fig. 6, the frame will require some sort of holder to keep it lined up while soldering. A paper-clip of the pattern shown in Fig. 7 answers very well (see Fig. 8). Or the parts may be held gently in a vice. Before repairing breaks like these, remove both lenses and both sides. Then thoroughly clean the parts, adjust them together correctly, and solder as before, observing the same precautions.

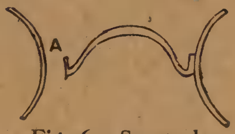


Fig. 6.—Spectacle Broken at Bridge Attachment

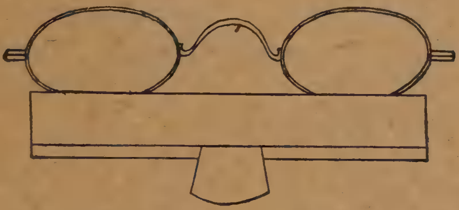


Fig. 8.—Spectacle Frame in Paper-clip

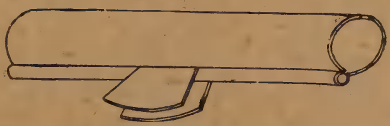


Fig. 7.—Paper-clip for Holding Spectacle Frame

Renewing Broken Side.—A broken side is best replaced by a new one. The new side will want its pivot hole opening with a rat-tail file to go over the turn pin, and perhaps the joint on the side may want trimming down to fit the frame joint. Its butt or stop may also require reducing to regulate the angle to which it opens, so that when open, as in Fig. 1, it matches the other side.

Replacing Lenses.—Spectacle lenses are not always both alike, and many must be put in the frame in exactly one position, as one side may have a spherical curve and the other a cylindrical curve. Therefore, before removing a lens or pair of lenses, always either mark them with a wax pencil, or gum little pieces of paper on their front faces with R on the right lens and L on the left. Then they can be replaced correctly.

Eye-glasses.—Eye-glasses are of all patterns, but one and all must line up properly. Both lenses must lie in the same plane; both plaquets (the cork parts that fix on the nose) must lie at the same angle and level with each other. Small parts, plaquets, steel springs, etc., are best replaced when broken; all can be bought at material shops. Loose corks can be cleansed and cemented on again in many cases with coaguline. Broken eye wires and other frame breakages can be soldered up as previously described.

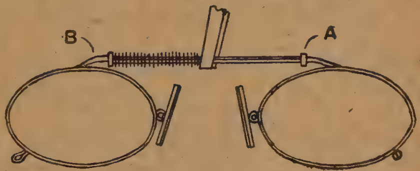


Fig. 9.—Holding Back the Spring of Eye-glass Frame

Astigmatic Clips.—These have become fashionable, and the slide is often a source of trouble to the repairer. Some people oil the sliding parts, but the oil gathers dirt and causes them to stick; dirt and grease accumulate in the slide and fix it. The remedy is to brush with a watch brush wetted in petrol or benzine, and thoroughly cleanse the parts, afterwards brushing dry and polishing up with a clean, dry brush. To act properly, the slide must be clean and dry. The little collars on the slide in these frames sometimes get loose; they are fixed with a minute quantity of soft solder. To resolder one, hold the spring back by a clip of some sort, such as a pin-vice, or hand tongs, as shown in Fig. 9, while the collar A is just warmed over a spirit-lamp flame, and a minute quantity of soft solder run in. Ordinary soldering fluid is used as a flux, and it must be washed off with a wet mop of tissue paper.

These frames often break at B, and require hard soldering. The frame must first be taken apart by warming one of the collars A, and separating the frame. After it is hard-soldered and cleaned up, the collar A must be soft-soldered in place again. To solder up joins of this kind, it is handy to lay the frame or parts on a sheet of asbestos, and pack up the parts with small pieces of iron until they lie in contact properly. They can then be soldered, care being taken to just warm the join by a gentle puff of the flame, to bake the borax before blowing the parts hot. This precaution will have the effect of preventing the borax from boiling up and so separating the parts.

Frosting Glass

THERE are several methods of making real and imitation frosted or ground glass. The original article is cheap enough, it is true, but it is often considered necessary to frost panes of plain glass which happen to be in their place, or small pieces of glass required for some special purpose.

To make real ground glass, lay the sheet, if possible, on a soft level bed of baize or coarse linen, and rub with a small flat piece of marble, using emery powder (common knife-powder will serve) or croydon or glass-cutter's sand as the abrading agent. If sand is used at first, the finishing rubs should be done with emery, as it gives a finer and better grain. Plenty of sand and water is used and the mixture is well rubbed into the surface of the glass by means of the marble. A circular movement is advisable in order to avoid any pronounced straight lines. When two pieces of glass are to be frosted, the emery or sand, with the water, may be placed between the two and the rubbing done with the top piece, which serves as the marble rubber. Particular attention must always be paid to the outside edges of the glass, as they are apt to get less of the abrading agent and less rubbing than the centre portion.

Temporary or artificial frostings, however, are more popular than the genuine thing, especially when it is impossible or inconvenient to remove the glass from its frame. Magnesium sulphate, better known as epsom salts, is largely used for the work, as also is sodium sulphate, and, when properly mixed and applied, either makes a very serviceable frosting. Take a little beer or water, preferably the former, warm it, dissolve in it as much epsom salts as it will take, and add a little office gum, or gum arabic dissolved in water. Then dab the warm solution on the glass with a flannel, and, as the mixture dries, a good frosted effect will be produced. If the window is likely to be fingered or scratched, it is advisable to give the frosted surface a protective coating of gum water.

A more permanent coating may be made with a mixture of white-lead. To 3 parts of boiled oil add 1 part of turpentine, then mix in white-lead to colour, and add a little patent driers. The colour must be rather thin and applied to the glass evenly. When the window has been painted over, take a new, dry, clean duster, and dab the ends of the brush bristles through the duster on to the glass rapidly until the pane is given a uniform ground-glass appearance, with no sign of horizontal or vertical brush marks. If the work is skilfully done, the effect will be exactly like real ground glass. To remove at any time after drying, dab on strong pearl-ash water till the coating is softened, when it will easily come away.

LIBRARY

Boot Repairing: Soling and Heeling

To the uninitiated, the statement that there is almost as much skill required in taking off the old sole as there is in fixing the new one may seem rather exaggerated; but it is, nevertheless, a fact. Careless handling when removing the old sole, otherwise termed "stripping," may result in serious damage to the lasting of the upper; that is to say that part of the upper which in making the boot is turned over or lasted on to the edge of the insole. If the boot has been previously re-soled, or if it is a boot made when new with what is termed an "outside clump," the risk of injury to the lasting is not so great as when the boot, being either a welted or machine-sewn, or even a riveted or screwed boot, has not been previously repaired.

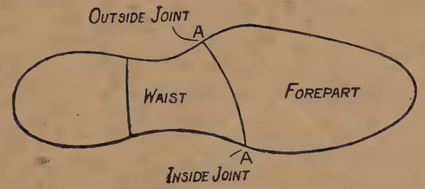


Fig. 1.—Sole Bottom, Showing Position of Joints, etc.

In a welted boot, the ground-work consists in a strip of leather being sewn along with the upper to a ridge or inseam on the insole. This strip is afterwards beaten up to stand out from the boot, thus forming what is termed a "welt," and to this welt the outer sole is stitched, either by the hand-sewn method or by machine. In repairing this class of boot the sole should be stitched on.

The machine-sewn boot is made by lasting or turning the upper edge over to the insole, and fastening the upper to the insole with tingles or short tacks. The outer sole is then sewn on by machine, the stitches passing through the sole and insole to the inside of the boot. A boot of this class may be re-soled by the use of brass or iron rivets. It is necessary to explain the difference in the manufacture of these two styles of boots, for if a sole is *riveted* on a *welted* boot, injury is done to the boot and the repair does not stand.

It is convenient to explain in this place how both riveted and sewn boots are stripped, the re-soling of hand-sewn work being fully treated later in this chapter.

Stripping the Old Sole.—In stripping a welted or machine-sewn boot proceed as follows:

Insert the point of a sharp knife between the welt and the outer sole, or the middle sole and outer sole joint marked A in Fig. 1. Hold the toe of the boot towards you, holding the knife level, and pull the knife firmly round (see Fig. 2), thus cutting the stitches, until reaching the joint of the boot opposite to that point from which a beginning was made. If the boot is a welted one the knife will slip round easily, meeting no opposition. If, however, the boot is of the machine-sewn variety, the knife will be found to come into contact with what appears to be a nail at intervals. These nails are termed "blinders," and are used to keep the sole in position whilst being sewn on during manufacture. When the knife comes into contact with one of these blinders, remove the point and re-insert it ¼ in. farther on. After having worked round from joint to joint, the sole can easily be lifted from the "blinders."

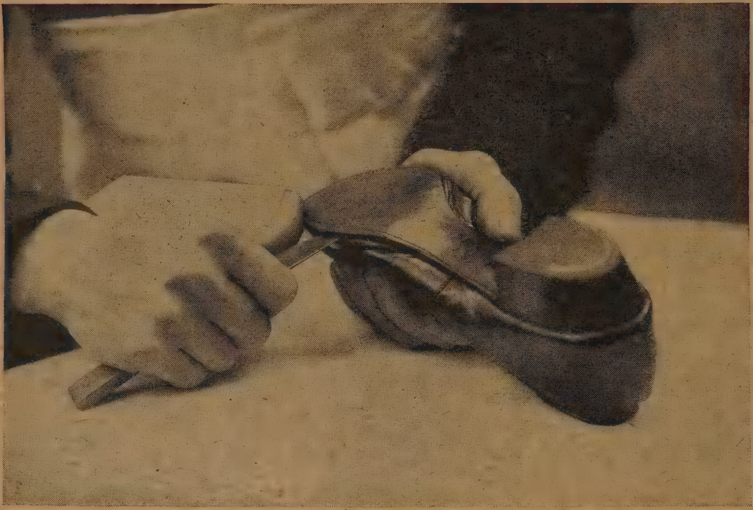


Fig. 2.—Stripping Sewn Work

In stripping a riveted boot or a screwed boot, a lifting awl will be required. This is a tool something like a small screwdriver, and can be purchased for threepence at any leather shop. Select the weakest or most-worn part of the boot to begin the stripping. Insert the lifting awl at this point, and release the sole from the rivets or screws. Now take hold of the released sole with the nippers or pincers in the right hand, press the thumb of the left hand firmly down on the middle, and proceed to strip from joint to joint (see Fig. 3), following up the thumb pressure on the middle sole as proceeding. This will prevent the tearing or lifting up of the lasting.

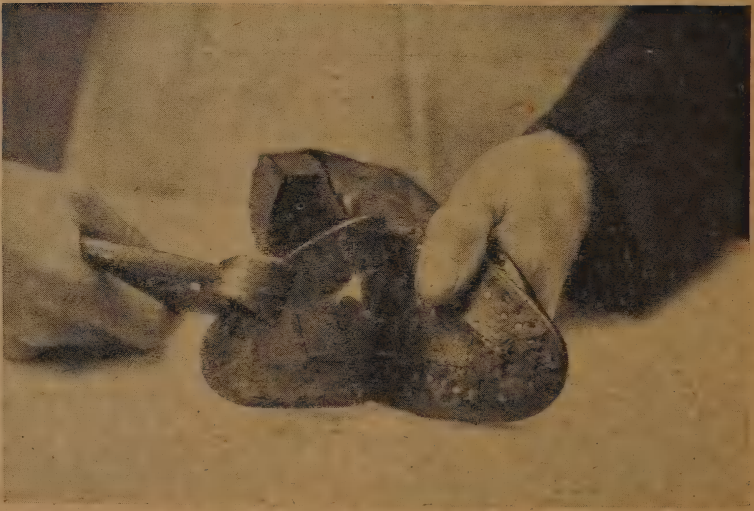


Fig. 3.—Stripping Riveted Work

Follow the same procedure with the screwed boot; but on no account must the screws, which will be left standing up, be withdrawn. These must be cut off as close to the middle sole as possible with a pair of cutters or pincers specially made for the purpose. These can be obtained at eightpence per pair upwards, according to size.

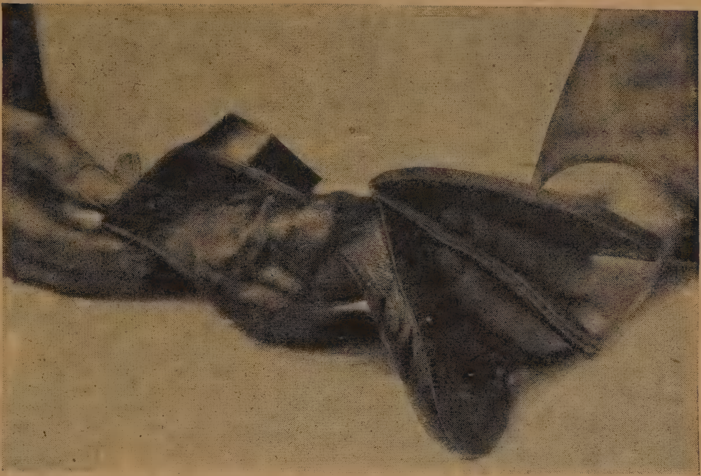


Fig. 5.—Shoe with Middle Sole

Women's machine-sewn boots are largely made on the single-sole pattern. That is to say, there is no middle sole between the outer sole and the insole. In stripping such a boot the knife point must be tilted slightly upwards, to avoid the risk of cutting the lasting of the upper.

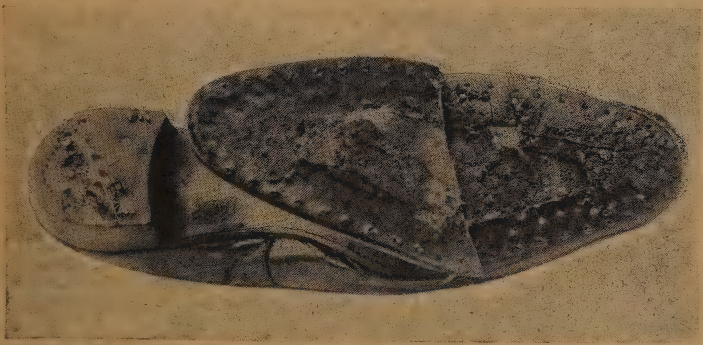


Fig. 4.—Sole Turned Back to Show Lasting of Single-soled Boot

Single-soled and double-soled shoes are shown respectively by Figs. 4 and 5.

Two classes of boots that must not be stripped at all are the turn shoe (commonly called a pump shoe) and the veldtschoen. The turn shoe resembles in appearance the single-soled machine-sewn boot. This shoe is made by sewing the upper to the sole itself on the *inner side* of the sole. There is no insole, consequently, if the sole is removed,

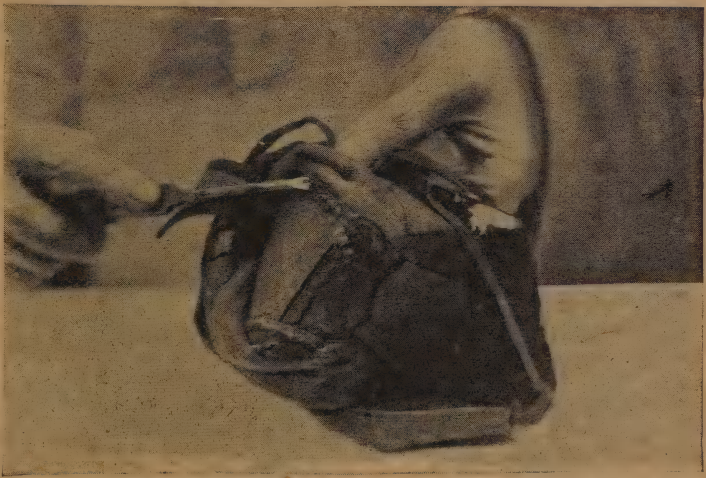


Fig. 6.—Turn Shoe, or Pump, Without Insole

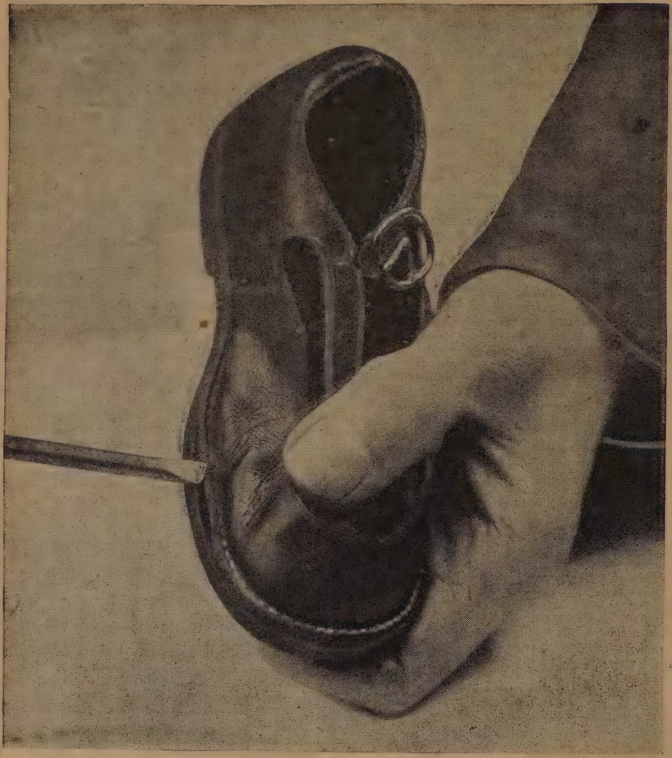


Fig. 7.—Veldtschoen, in which Upper is Stitched to Sole Outside

nothing is left but the upper (see Fig. 6). The veldtschoen, usually children's goods, is made by sewing down the upper to the sole *outside* (see Fig. 7), and this shoe also is without an insole. To distinguish the turn shoe from the machine-sewn shoe, take the socking out of the shoe, and in the case of the turn shoe the edge of the upper will be distinctly seen inside the shoe. The veldtschoen can be recognised by the edge of the upper being seen to lie on the welt. These two classes of shoes must either be repaired in the same manner in which they are made, or the new half-sole placed on top of the old, that is, "clumped."

Having released the machine-sewn or welted boot sole to the joints, hold up the sole with the left hand, hold the knife upright in the right hand, and cut the sole through at the position of the joints. Make a straight cut, not slanting the knife as in Fig. 8. With the back of the knife make a mark on the sole about 1 in. behind the knife cut—that is, in the waist of the boot. Now from this

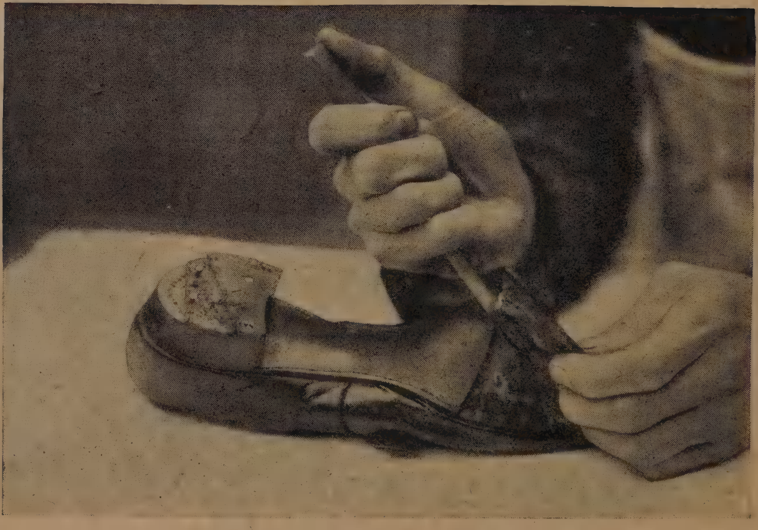


Fig. 8.—Cutting off Old Sole

mark, thin down the old sole (see Fig. 9), working from a slight skive at the mark to a substance of about $\frac{1}{16}$ in. at the cut edge. When this has been done and the skived surface smoothed the stripping is complete.

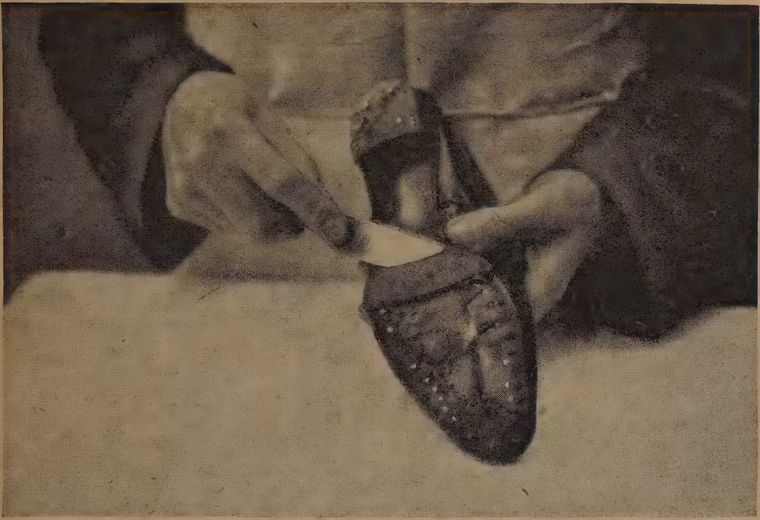


Fig. 9.—Skiving Waist of Old Sole

In the case of the riveted or screwed boot, turn back the sole and force out the rivets, or cut off the screws to a point 1 in. below the joints. Cut off the sole across the joints, mark, and skive down as previously described.

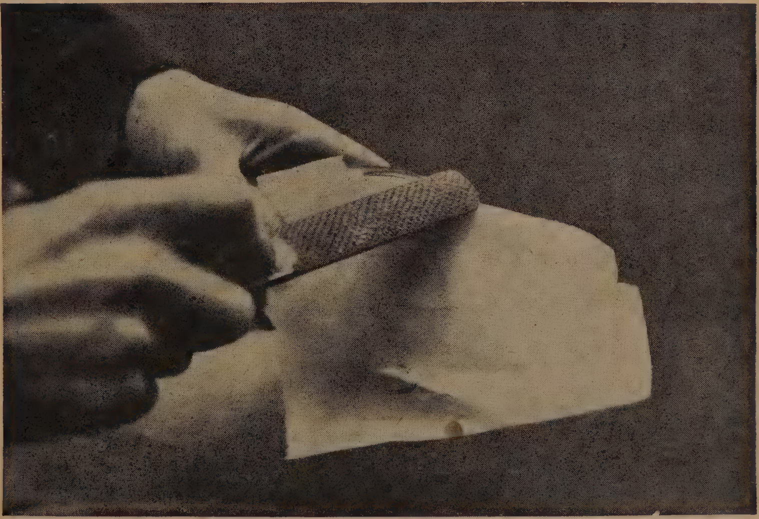


Fig. 10.—Taking Paper Pattern for New Sole

ATTACHING THE HALF-SOLE AND HEEL

Examining Middle Sole.—As already stated, the riveted, screwed, and machine-sewn are the kinds of boots that will permit of the readiest method of half-soling—that is, riveting on the sole.

First of all, examine the middle sole, and, if it has "lifted" or become insecure in any place, fasten it down, using $\frac{3}{8}$-in. tingles for a light middle, and $\frac{1}{2}$-in. tingles for a stout one. If the middle sole has been worn through, or thin, in any place (generally the outside joint or at the toe), skive a piece of waste leather to the required substance to make up the worn middle to the substance of the rest of the middle. Fasten with tingles, and also drive a few tingles in the waist so far as it has been released.

Cutting Out New Sole.—For cutting a pattern for the sole, place a piece of paper on the boot bottom large enough to cover, the bottom end of the paper reaching the back skiving mark in the waist. Hold this paper down to the boot with the left hand, take a shoemaker's rasp in the right, the file side downwards, and, starting at the joint, file through the paper to the edge of the middle sole, working round to the other joint (see Fig. 10). This will give an exact pattern of the half sole required. Place this pattern on the leather on the flesh side (or unpolished side), so that any "flay" marks or cuts in the leather may be observed and avoided. Mark round the pattern with the back edge of the knife point, and turn the pattern over before marking for the other sole. This is necessary, or there will be two rights or two lefts, as the case may be, instead of a right and a left pattern.

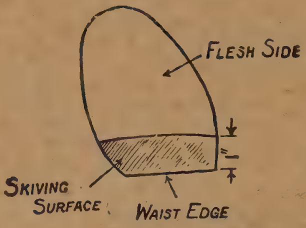


Fig. 11.—Diagram of New Sole, Showing Skiving

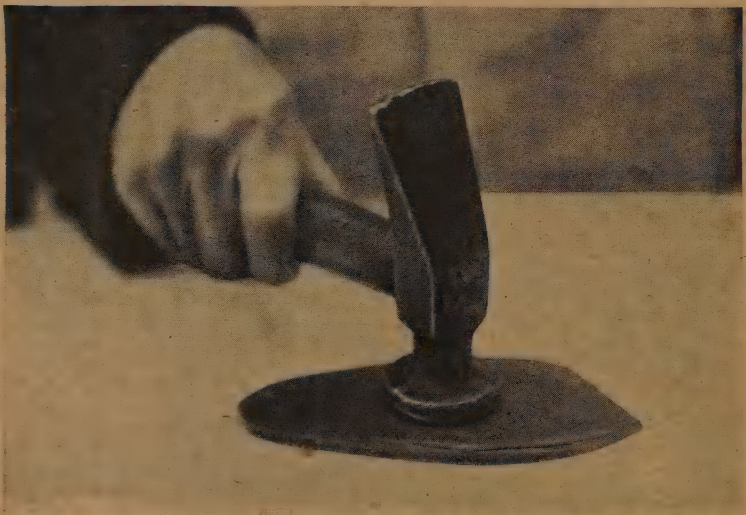


Fig. 12.—Hammering a New Sole

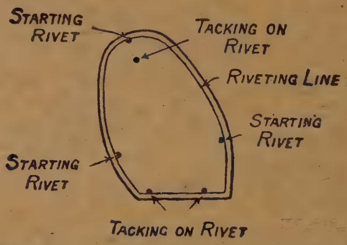


Fig. 13.—Diagram Showing "Tacking on" and "Marking" for Riveting

Preparing and Fitting the Sole.—Having cut out the soles, the next job is to prepare the waist of the new sole. Turn the sole over to the flesh side, mark a line across the waist 1 in. from the waist edge, and skive down from this mark to the edge, graduating from a slight skive at the mark, until sufficient material is skived away to bring the waist edge to a $\frac{1}{16}$-in. substance (see Fig. 11). To facilitate the easier skiving, the sole should have been previously soaked in water for a little time, and then allowed to partly dry off, thus rendering the material more mellow. Now lay the sole, grain (or polished) side downwards, on a domestic flat-iron of smooth surface, and hammer gently and even all over the sole (see Fig. 12). The face of the hammer must be brought down perfectly level on the sole, or the grain of the leather will be broken.

Next fit the sole in position on the boot, taking care that the skiving of the waist of the boot is properly covered by the waist of the new sole. If this is not done, the waist will break away in wear.

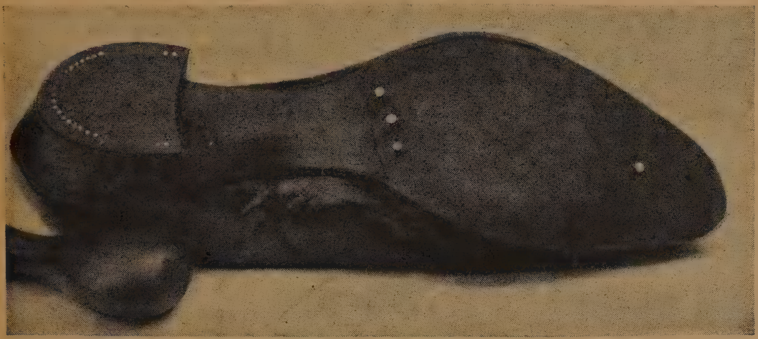


Fig. 14.—"Tacking on" of New Sole

Attaching the Sole. — Having placed the sole in position, drive a rivet near the toe, and two or three rivets in the waist to hold the sole in position whilst the surplus material is trimmed off. These are termed "tacking-on" rivets (see Fig. 14). In trimming up or rounding the sole, hold the boot with the toe towards you. Hold the knife with the point upwards, and begin the trimming at the joint to the right hand, working towards the toe, as in Fig. 15. Having reached the toe, turn the boot round, bringing the heel next to the worker, and work down to the other joint.

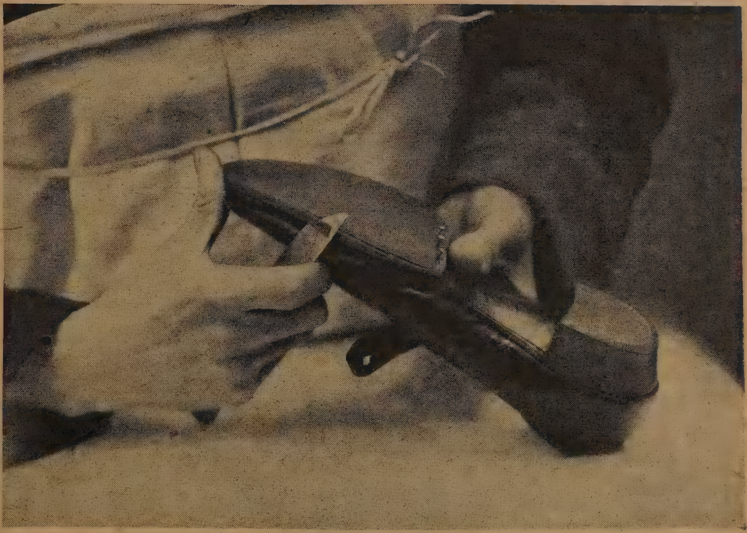


Fig. 15.—Rounding the Sole with the Knife

Now take a knife or sewing awl, and, beginning about $\frac{1}{3}$ in. inwards, mark a line round the sole at this distance for the rivets (see Fig. 16). If the boot has a wide middle sole or welt, as it may be termed, the marking will have to be made correspondingly farther inwards, as the rivets must penetrate (and meet the last) through the insole. Place a rivet at each side of the joint and one at the toe on the riveting line, to keep the sole firmly down in position (see Fig. 13). Begin riveting at the left-hand joint, working right round the sole and across the waist, placing the rivets about four to the inch. Next hammer down the sole to clinch the rivet points and level the bottom. Hammer down any raised surface, or this raised surface, if left unlevelled, will quickly wear away.

The rivets used should be long enough to penetrate the sole, middle sole, and insole, the points just touching the last, and no more. If the rivets are longer or shorter than this, the solidity of the job is impaired. Brass rivets should always be used for the soles, as iron rivets are apt to rust in wear, and rot the material, besides making the work of stripping on the next occasion very difficult.

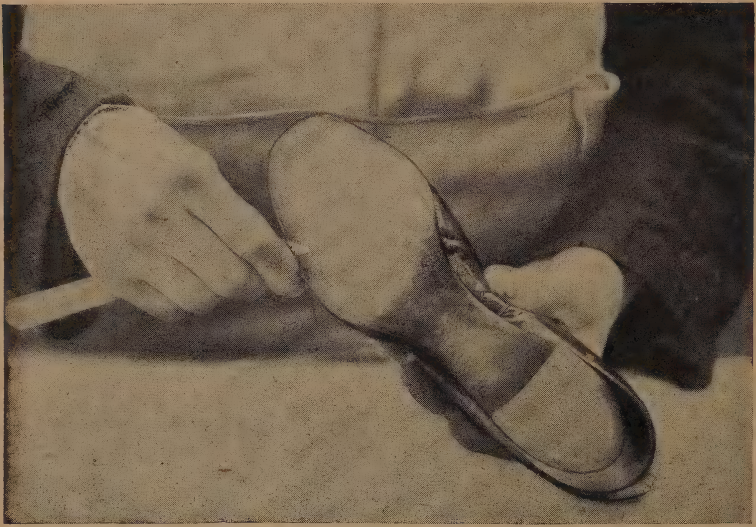


Fig. 16.—Marking Sole for Riveting

Whatever may be the opinions from a health point of view, it is certain that the quickest riveting speed is obtained by holding the rivets in the mouth. Place a small quantity in the bottom of the mouth under the tongue. A little practice enables the worker to single out the rivets with his tongue, bringing them forward, one at a time, between the teeth, the rivet point projecting first between the lips; at the same moment, the left hand is brought upwards to the mouth, taking hold of the rivet in the middle with the finger and thumb, and it is then an easy matter to bring the rivet straight down to the riveting line point first. Hold the rivet at a slight angle. Whilst the rivet is held in position with the finger and thumb, tap the rivet head with the driving file to fasten, then drive flush with one or two taps.

Heeling.—The next operation is heeling. The topmost layer of leather on the heel is termed the top-piece. Place the lifting awl under the weakest or most-worn part and raise the top-piece; then remove it with the aid of the pincers. If the heel is worn down below the top piece, chop away the worn part with an old knife until a level "lift" is reached (see Fig. 17). Next fill up the space made with odd pieces of leather until the heel is level. Trim the surplus of odd pieces to make the built portion conform to the contour of the heel.

Then make a pattern for the top-piece in the same way as the pattern was made for the sole. Cut out the top-piece, soak in water, and hammer on the flat-iron. Place the top-piece in position on the heel, and drive a couple of $\frac{3}{4}$-in. iron rivets about $\frac{1}{2}$ in. apart at the front of the heel, and one near the back, to hold the top-piece firmly in position. Trim off the surplus leather to make the top-piece conform to the lifts underneath. Then mark round about $\frac{1}{4}$ in. inwards, and place three rivets on the side of the heel which is not touched in wear, these rivets being placed at equal distances, beginning from the extreme heel corner. Now begin at the other heel corner and rivet round, keeping the rivets very close together, until the first of the previously mentioned three rivets is reached.

If the wearer is heavy in wear on the

heels, place a second row of rivets just inside the first row, and after hammering down the top piece to level, the heeling is complete, and the boot, now soled and heeled, is ready for finishing. This work is *not* done as described in an earlier chapter for new work, but full instructions will be found on later pages.

SOLING AND HEELING HEAVY NAILED WORK

Early Precautions.—Unless a high price has been paid for heavy nailed boots it will be found, on stripping for re-soling, that the bottom is weighted, or made up, by the use of "runners," which are strips of leather about ½ in. wide, something like a welt. These are "run" round the forepart of the boot after lasting, and then a light middle sole is added, the whole forming a stout edge for the reception of the long shanks of the hobnails or fitters. After stripping, which should be done very carefully so as not to disturb the runners more than possible, any part of a runner worn through should be cut away and a fresh piece let in. If there is no middle sole on the top of the runners, a middle should be cut from a piece of "split shoulder," which can be obtained from the local leather shop. This is not needed to be of stout substance, its use being simply to "bind" the runners and keep them from spreading when the sole is being riveted on. If no such middle is used, and the sole is riveted on the top of the bare runners, the runners will be almost certain to bulge out during the riveting of the sole.

Attach the split middle at the outside joint first by driving a few long tingles through the middle and into the runners. Then pull the middle tightly over to the inside joint, and fasten in the same way. Next, between the toe and the outside joint, press the runners well inwards, and fasten the middle whilst in this position. Repeat the operation between the toe and the inside joint, then tingle down the toe itself.

Attention must next be given to the packing of the forepart. The nailing in rows will result in the centre of the boot sinking unless the forepart is well filled. The best filling will be made from the tops of old boots, and the filling should be sufficient to be raised slightly above the level of the edges, so that, after nailing, the hammering down of the nails will result in the perfect levelling of the bottom.

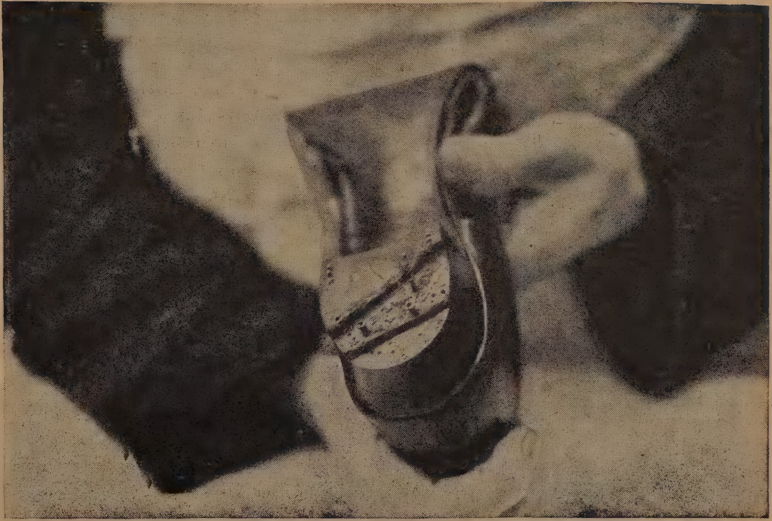


Fig. 17.—Heel Cut Away for Repairing

The Insole.—Very often in heavy nailed boots, and particularly those made with runners, the insole breaks across the waist in wear. In such a case an insole should be cut from the same kind of split shoulder as described for the strengthening of the runners. This insole should be cut of a length sufficient to reach 1 in. below the crack, or break, of the boot insole. Fasten in position by driving a couple of tingles across the waist end of the split insole from the inside. The sole in such a case should also be cut of extra length, so that the waist of the sole will be in line with the waist of the split insole.

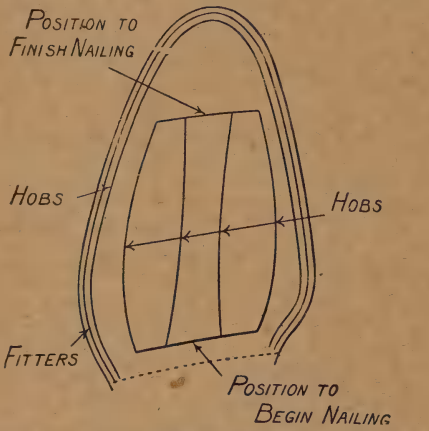


Fig. 18.—Marking Heavy Boot for Four-row Centre

Riveting.—If, after tacking on and rounding up the sole, there is any doubt about the solidity of the runners, it is advisable to rivet close to the edge. Mark $\frac{1}{8}$ in. from the sole edge, use iron rivets, and drive at an angle that will ensure the rivets properly catching the insole. The rivets must be long enough to catch the last, as the idea is to "bind" the runners between the sole and the insole. If, however, the runners seem quite solid, mark round for riveting at such a distance as will allow of the placing easily a hobnail on the outside of the riveting line.

Nailing.—The ordinary styles of hobnailing are by round hobs only, and by a row of "fitters" on the outside edge, hobs being then used for the rest of the sole. If "fitters" are used, the handiest size is that termed the **C** fitter. There are cast and wrought varieties of this nail. The wrought nail, of course, is much longer wearing, and is not so apt to break off at the head during wear, but it costs much more than the cast nail.

In starting to nail with fitters, begin at the joint of the boot to the left hand. It will be noticed that one edge of the fitter is wider than the other. Drive the first fitter with its wide edge to the outside of the sole. Then fit the next nail close up to the first with its narrow edge to the outside of the sole. Follow up with the third with its wide edge to the outside, and proceed in this way all round the sole. To obtain correct results it is necessary to fix each fitter nicely into position before attempting to drive. The nails should fit all the way round so closely and squarely as to give the appearance of a strip of metal having been attached to the sole.

After nailing with fitters, begin at the same joint and drive the first hobnail close up to, and level with, the first fitter. Let this be the nailing line for this first row of hobs, keeping close to the fitters all the way round, and each hob just touching the next one. This close nailing is to prevent the lodging of dirt between the nails.

If the boot is a wide-bottomed one, mark four lines as shown in Fig. 18. These lines should begin about 1 in. from the sole waist-edge, and extend to the point where the toecap edge would be if the boot has a toecap. The line on the inside of the boot should extend $\frac{1}{4}$ in. farther than the next line, each line shortening $\frac{1}{4}$ in. towards the outside as shown.

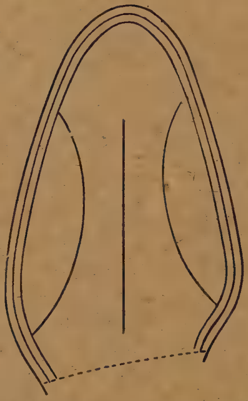


Fig. 19.—Marking Heavy Boot for Three-row Centre

If the boot has a narrow bottom, three

lines up the centre will be sufficient, whilst a medium-width bottom can be served by nailing in the manner shown in Fig. 19. The most suitable hob is that known as the "middle Vic" (Victoria), which goes very well with the **C** fitter. In nailing on these lines it should be seen that the nails are kept close and square.

Neat nailing may be ensured by marking for the hobs. At most leather shops a steel marker with three prongs can be obtained, the space between the prongs being equal to the width of the hob, and different sizes of markers are made to provide for different sizes of hobs. To start the marking, hold the tool upright on the nailing line, with the lower prong square on the beginning of the mark. Tap the top of the tool lightly with the light hammer. Next place the marker in position with its lower prong resting in the topmost hole previously punched, and proceed in this way to the extent of the marking. If the tool has three prongs it will be seen that three holes are first punched and two only for the rest of the marking, at a time, one prong thus acting as a guide in placing the tool in position.

Nailing with "Cuts" or Brads.—This style is usually done as follows: A row of small hobs is driven round the sole edge. The "cuts," or French brads, which are square nails something like a carpenter's flooring nail, only smaller and without a flanged head, are then driven in the same style as driving the hobs—that is, close up to the fitters; but a little space is left between each cut, and they are only driven so far down as to be level with the tops of the fitters.

Toe-plate. —A toe-plate is a thin flat piece of metal about ¾ in. wide across its centre, and having five or six countersunk holes for attaching to the sole, either with screws or special studs. Before attempting to fix, the plate should be laid on the hollow of the last at the waist, under-side upwards, and tapped with the hammer in the centre and at the corners, so as to slightly "round" the upper-side of the plate. It will then "bed" to the sole easily in fixing. If this is not done one corner, after fixing, may rise up as the other corner is being fixed; even if this does not happen, the plate will be certain to work loose during wear. There are two strengths of toe-plates usually adopted, the ordinary light plate and the "Scotch toe" for extra heavy boots.

Toe-tips.—These are of exactly the same form and substance as an ordinary heel-tip, except that they are fashioned to the shape of the toe instead of the heel. There is also an extra heavy tip made. A toe-tip works very well where fitters are used, taking the place of these nails at the toe. To ensure solid fixing, the corners of the tip should be slightly tapped inwards. The toe-tip is attached with short plugs similar to those used for attaching the heel-tip.

In using either plates or tips for the toe they should always be fixed before any nailing is done. After rounding the sole very carefully at the toe, the tip or plate should be held in position, and the plug holes marked with a sewing awl. Then, when riveting the sole round the toe, it should be noticed that the marks so made are avoided by the rivets. If rivets are placed in the position where the plugs or screws have to go, it will cause much trouble in fixing the plate or tip, and result in the rivets which are in the way of the plugs working through to the insole.

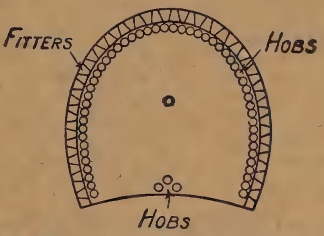


Fig. 20.—Heavy Nailed Top-piece

The Heels.—In heavy nailed work a tip is generally used for the heels; but sometimes a nailed heel is preferred. In the latter case the top-piece is closely rounded, and fixed with only a few iron rivets, the marking line being well inwards. Fitters are then driven close to the edge, beginning at one heel corner and working round to the next heel corner. A row of hobs is next driven round close up to the fitters. Three hobs are next driven at the breast of the heel and one at the back centre as shown in Fig. 20. This style of heel is, if anything, longer wearing than the heel repaired with a tip. It has also another advantage. If the wearer is heavy at the back of the heel, whilst the rest of the top-piece is scarcely touched, as very often happens, it is a simple matter to knock out the worn fitters and hobs and replace with new.

Re-nailing an Old Sole and Heel.—Drive out all the old fitters and hobs, the best tool for this purpose being an old shoe knife of the stout type. Place the knife edge low down by the side of the hob, tap the back of the knife with the hammer, at the same time slightly tilting the knife upwards whilst the blow is being struck. This will quickly lift the old nails. If the hob or fitter heads have been worn away, and only the shank is left in the sole, these shanks will be best lifted by the use of a fine screwdriver. After removing all the old nails, dip the sole and heel in water and allow them to "mellow." Next fill all holes with wooden pegs, either $\frac{1}{2}$ in. or $\frac{5}{8}$ in., according to size of nails previously used. Then proceed to re-nail in the same holes as before. If nailing is attempted between the holes disaster will follow, as the leather will break between the new holes and the old.

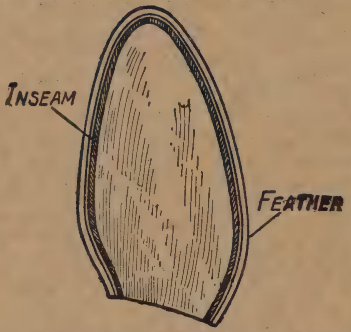


Fig. 21.—Position of Inseam on Inner Sole

HAND-SEWN REPAIRS

Remedying Insecure Welt.—Attention will now be devoted to the method of renewing the sole of a hand-sewn or machine-made welted boot. Having stripped off the soles in the manner already described in this chapter, take out the filling that occupies the space between the inner sole and outer sole, and examine the welt and inseam. The inseam is the ridge round the edge of the insole (see Fig. 21). On the inner side of this ridge will be noticed the stitches which bind the welt and the upper to the inseam, the edge of the upper occupying the position between the inseam and the welt. Press the thumb down on the welt all round the forepart, and notice if the welt is insecure, or has broken away from the stitches at any point.

If so, take a short thread and a sewing awl with a medium curve at the shoulder. Insert the sewing awl in the next stitch hole to where the break has occurred, or where the weakness of stitches begins, on the inner side of the inseam. Work the awl in such a manner that its point emerges on the welt in line with the welt sewing, which can clearly be seen. Withdraw the awl, and insert the bristle from the inseam side. Pull gently at the bristle when it emerges on the welt until the thread proper comes through. Now take hold below the bristle, pull firmly, and draw through half the length of the thread. Insert the awl in the next stitch hole on the inseam side, taking care to bring its point out again on the welt in the sewing line. Insert the left-hand bristle first in the hole on the welt, and then the right-hand bristle in the hole on the inseam side. Force both bristles through, take hold of the bristle emerging on the welt with the finger and thumb of the left hand, and on the bristle emerging on the inseam side take hold with the finger and thumb of the right hand, and pull gently and evenly at both bristles until a few inches of the thread proper are drawn through on each side. Now take hold of the thread well down on each side, pull firmly and quickly with an even pull, and draw up tightly. This makes a complete stitch on the welt and the inseam. Follow this method until the broken or insecure part is covered. When the last stitch is put in, insert the awl in the next stitch hole from the inseam side. Insert the left-hand bristle from the welt side, and draw this thread right through to the inseam side. Both threads will now be on the inseam side. Tie the ends together close down to the insole, and hammer down the knot.

The Filling.—Next examine the filling previously removed. This filling is sometimes of felt only; but in the case of machine-made welted boots it is more often made of a combination of cork dust and pitch. In the latter event a portion of the filling generally comes away with the sole when stripping. In such a case the best plan is to discard this filling altogether, and refill the bottom with felt, which may be obtained at the leather stores at sixpence per square yard. Use the old filling for a pattern.

The cutting of the felt will be made much easier if the knife is slightly heated before using, and for this reason an old knife should be kept specially for the job. Lay the felt in position and "bed" it down nicely, so as to have a level bottom.

The Sole.—Next take a pattern of the soles, and cut out as described in the chapter already referred to. The leather will require to be much more mellow and pliable for sewing than is needed for riveted work; and for this reason, the piece of leather from which the soles are cut should be left in water over night, taken out in the morning, and allowed to drain off.

Having cut out and hammered the soles, turn them flesh side up on the cutting board. If the flesh or fibre is loose, trim this off with a sharp knife about 1 in. inwards all round the sole, as the loose flesh impedes the passage of the bristle when sewing. Place the sole in position, and drive a few rivets across the waist. Now take hold of the toe end of the sole, and pull firmly towards the toe of the boot. This takes the "draught" out of the sole, and permits of the better laying of the sole during the sewing. Hold tightly in this position whilst driving a long rivet near the toe end. Do not drive this rivet flush, as it will afterwards require to be withdrawn and replaced by a wooden peg. Drive another long rivet well inwards at each joint, and trim the sole round close to the welt. Now run the rasp round the edge (see Fig. 22), as if rasping up for finishing, holding the sole tight to the welt with the left hand. File off the "burr" from the sole edge.

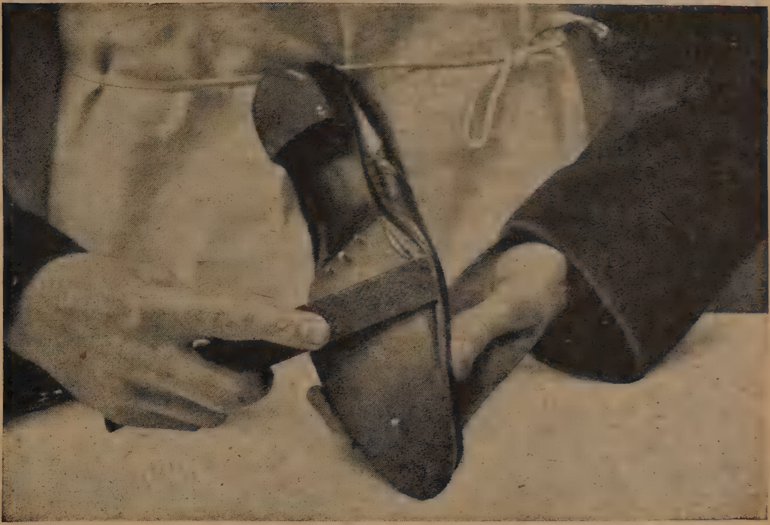


Fig. 22.—Running Rasp Round Sole

Making the Channel.—With the point of a sewing awl, beginning at the joint to the right, with the toe of the boot next to the worker, begin marking the sole $\frac{1}{8}$ in. inwards, and continue this mark round the sole to the opposite joint.

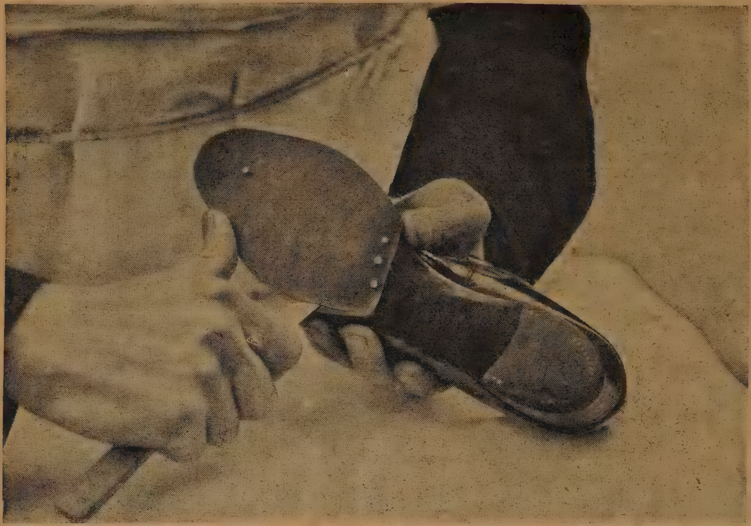


Fig. 23.—Cutting Channel in the Sole

This marking is for the channel in which the stitches will have to be buried. The best knife for cutting the channel will be one with a short blade, slightly rounded at its point. Hold this knife firmly in the four fingers of the right hand. Place the point of the knife at the beginning of the mark on the joint to the right, pressing the right thumb against the sole edge. Hold the knife in a perpendicular position, and begin cutting downwards into the leather (see Fig. 23). Move the knife, as the cutting proceeds, forwards, moving the thumb in unison with the knife. The position of the thumb will help to guide the knife whilst cutting, as it is necessary to keep on the line previously marked. Proceed in this way round the sole to the opposite joint, and judge the depth of the cutting to about half the substance of the sole. The corners of the joints are much lighter in substance than the rest of the sole owing to the skiving of the waist, so that care must be taken at these points not to cut through the material.

It now remains to open the channel. For this purpose use the blade of a small screwdriver. Force a corner of the blade into the beginning of the channel at the joint to the right. Drag the tool forwards in such a way that the leather behind the knife cut, nearest the middle of the boot, is lifted up and forced backwards

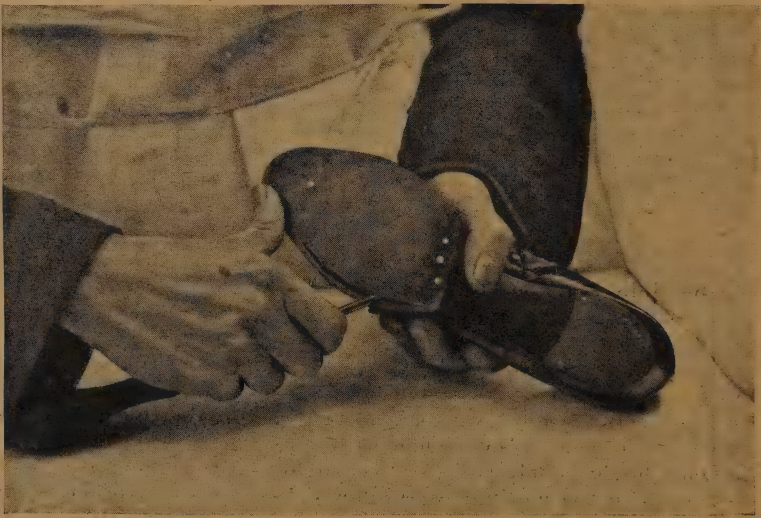


Fig. 24.—Opening the Channel in the Sole

(see Fig. 24). Be careful not to chip or injure the leather so raised, as this portion, termed the "lip" of the channel, has to be smoothed back into position after sewing to cover the stitch, and any portion of the lip chipped away will result in a bare stitch after the channel is laid.

Sewing.—Having now opened up the channel, sewing can be begun. First of all withdraw the iron last, or hobbing foot, from the boot, and insert a wooden last in the boot instead. Now rub a damp piece of cloth round the welt to soften the welt a little. Place the boot on the left knee, toe towards the worker, sole bottom to the left, and fix the stirrup over the waist of the boot and under the left foot. The stirrup is a piece of rope tied at the ends, of a length when tied to reach from the boot on the knee to the floor, and by regulating the rope by the foot the boot may be held tightly down on the knee, thus having the free use of both hands.

If the boot is of ordinary walking substance in men's, use a thread of ten strands; if ordinary substance, women's, use a thread of eight strands.

If a wide welt, select a sewing awl with only a slight curve; but if the welt is close or narrow an awl with a sharper curve will be required. A medium-size awl will be suitable for the men's work, and a lighter one for the women's.

A guide for the correct size of awl is as follows: Insert the awl just far enough for the point to protrude in the channel, then draw the two ends of threads through. If firm pulling is required, the size of the awl is correct; but if the threads pass easily, the awl is too large in size. A point to be remembered is that in sewing, the awl should not protrude in the channel any farther than its bare point (see Fig. 26).

Begin sewing in the waist of the boot, a couple of stitches below the edge of the waist of the new sole. Insert the left-hand bristle first, then the right-hand bristle, and pull gently through until a few inches of thread are drawn through on each side. Twist the hollowed part A (Fig. 25) of the awl handle round the right-hand thread, and the left-hand thread over the hand leather and round the back of the hand. Pull at each thread with evenness until the stitch is tightly pulled into the channel and on the welt (see Fig. 27).

The hand leather mentioned is shaped like a glove without fingers, and a hole is cut in the leather through which the thumb protrudes.

The point of the sewing awl should be placed about $\frac{1}{16}$ in. from the welt edge, and the awl held at such an angle that its point will penetrate the channel, which is cut $\frac{1}{16}$ in. farther inwards on the sole.

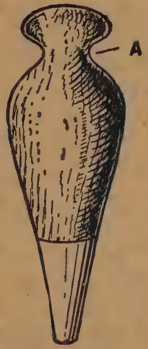


Fig. 25.—Handle of Sewing Awl

Care must be taken when pulling up the stitch on the sole side that the thread does not catch the "lip" of the channel. Sew about eight stitches to the inch for ordinary substance men's walking boots, and about ten stitches to the inch ordinary substance women's walking boots. Proceed with the sewing as described to a couple of stitches beyond the waist edge on the opposite joint. Cut off the threads close to the welt and the channel.

The next operation is to "paste" the channel. Make this paste with rye flour and warm water to a rather stiff consistency. Fill the channel, over the stitches, with this paste, and turn down the "lip" into position with the knifehandle. Now rub round the channel with "the long stick" to lay properly. Tap down the sole, and leave to dry, having first withdrawn the long rivets and driven in

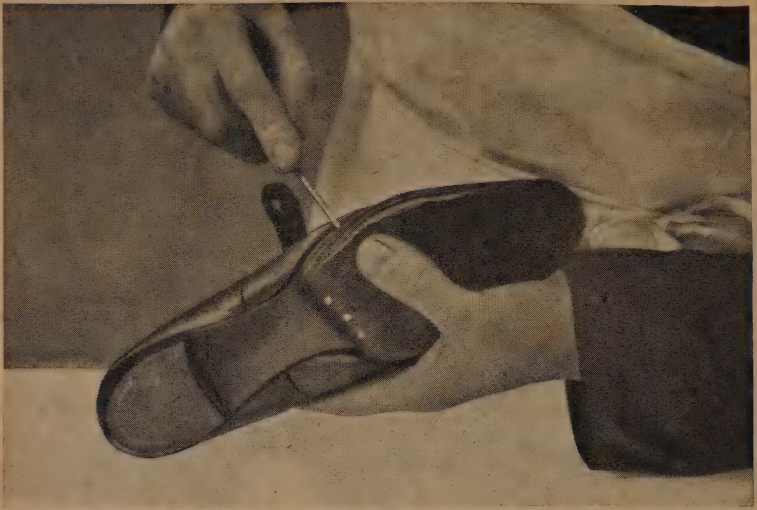


Fig. 26.—Inserting Sewing Awl

elsewhere in these volumes.

Remedy for Creaking Boots. — Creaking is caused generally by the outer-sole rubbing against a hard inner-sole, and is best obviated, when making a new boot, by inserting a piece of felt between the inner- and the outer-soles. Once the boot has been made, however, this method, involving the stripping of the fore-part, is usually considered inconvenient. The annoyance may be overcome by one of the following methods: The simplest method, which may act when the creak is caused by the outer-sole rubbing against a hard middle, is to drive three or four rivets through the outer-sole across the tread of the boot. These

wooden pegs in their places. When the sole and the pasted channel are thoroughly dry proceed to "finish" off the work as previously described.

The following points in sewing round a sole are the essential ones to be remembered: The size of the awl used should be only so large that when both threads are in the hole they require firmly pulling to pass through. The point of the awl must only just penetrate the channel. Have the wax handy, and give both the left and right threads a few rubs every half-dozen stitches. In addition to these points, special care must be taken to prepare a reliable and well-finished thread, a matter fully dealt with

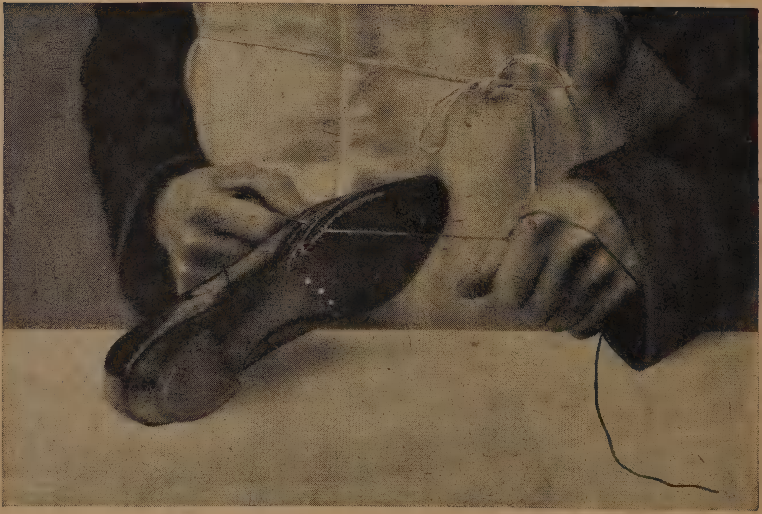


Fig. 27.—Pulling a Stitch Tight

rivets should be long enough to penetrate the insole, and just touch the last. They hold the inner- and outer-sole together and prevent any relative movement. Another method is to release a few stitches on the joint of the sole, to put a small quantity of powdered blacklead into a dry oil-can and then to "blow" the powder under the sole at the spot where the stitches have been released. The sole should then be firmly sewn down. Another method is to bore a few holes on the boot soles in a slanting manner just penetrating to the middle sole. Oil is then squirted in from the oil-can, and the holes afterwards hammered down. The holes would be best made with a strong sewing awl.

FINISHING SOLES AND HEELS OF REPAIRED BOOTS

Tools and Materials.—Before attempting to finish a pair of boots that have been soled and heeled the worker should see that he has the necessary tools and materials. For home purposes the following tools purchased at the local leather dealer's, will meet requirements: An 8-in. rasp (three-quarter rasp and one-quarter file); a buff knife or scraper of the shape shown by Fig. 28; a $\frac{1}{2}$-in. forepart iron with single guard (Fig. 29) ready cut; and a burnishing iron for the heels, single handle, as shown in Fig. 30. With these tools a fairly good finish can be obtained on practically all classes of repairs.

It will be necessary to purchase some shoemaker's ink and heel-ball. "Burnishing ink" should be asked for and $\frac{1}{2}$ pt. is sufficient for a large number of repairs. One black heel-ball will do for several pairs.

Sharpening the Scraper.—The buff knife, or scraper, will probably require putting into working order. To accomplish this place the scraper flat on a piece of board, with one end projecting a little over the edge of the board. Hold the scraper firmly down to the board with the left thumb. Take a sewing awl in the right hand, place the awl flat on the end of the scraper projecting over the board, press firmly down and rub backwards and forwards, making about a dozen strokes and taking care to rub well at the scraper corners. Turn the scraper over, and treat the other side in a similar manner. (Instead of holding the scraper flat on a board, it can be held as in Fig. 31, but the other method is the more certain.) Now turn the scraper round, and perform the same operation at the other end. Having done this take up the scraper, and wrap a piece of cloth round one end, so as to obtain a better grip in holding. Hold this end firmly in the left hand, and work the awl backwards and forwards on the direct edge of the scraper (see Fig. 32). It will then be found that this operation has as it were, turned the edge over to each side, and this forms the scraping edge. Treat the other end of the scraper in the same manner, and the tool is ready for use.

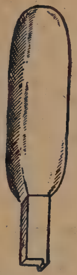


Fig 29.—Fore-part Iron with Single Guard

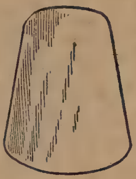


Fig. 28.—Buff Knife or Scraper

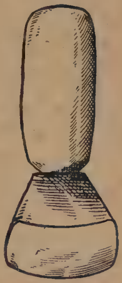


Fig. 30.—Single-handled Burnishing Iron

Bottom Finishing.—First of all damp the heels and edges with water, using a small brush for the purpose. This will result in the leather becoming mellow whilst finishing the bottom. Using the smooth or file side of the rasp, file the heads of the rivets all round the sole and top-piece. Next, holding the scraper almost upright and using the widest end, scrape away the grain of the leather and the marks round the rivets caused by the file. Now glasspaper the bottom and top-piece with a quick circular motion. Brush off the dust, and everything is ready for applying the bottom wash or stain.

A general idea is prevalent that the scraping of the sole bottom takes a week's wear out of the leather. This is a mistaken idea, as the leather wears much better if the grain is scraped off and the bottom made up.

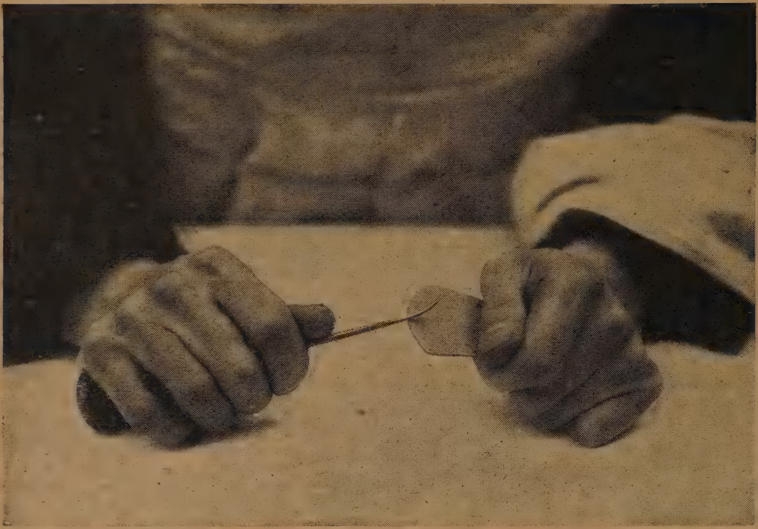


Fig. 31.—Sharpening the Scraper: Thinning Down the Sides

The simplest wash, and a good one, is made by mixing a wineglassful of "liquid ammonia" (properly, liquor ammoniæ) with ½ pt. of milk. Shake well and pour a little on a piece of flannel. Wipe the bottom and top-piece quickly with the damp flannel, and the bottom is finished.

If a bright or burnished bottom is required, obtain a "long-stick" from the leather shop. This is made of boxwood, and will cost a shilling. Grasp the ends of this stick firmly, press hard down on the sole bottom, and rub quickly from the waist to the toe. The leather will thus burnish up brightly. This bottom is much favoured, as it has a natural leather appearance, and the wash and long-stick have the effect of hardening the grain of the leather and prolonging its wear to some slight extent.

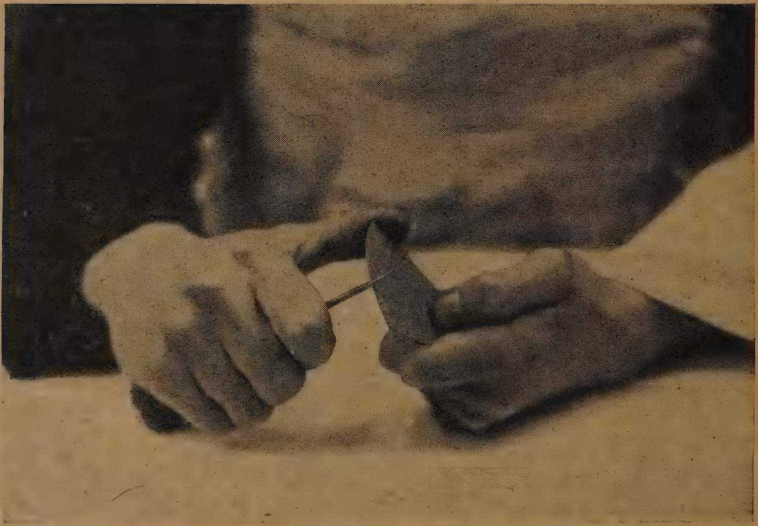


Fig. 32.—Sharpening the Scraper: Turning the Edge

Edge Finishing. — With a small sharp knife, next proceed to trim off as closely as possible the surplus leather overhanging the welt, or middle sole, and round the top-piece. The edges are now ready for rasping. Hold the boot in the left hand,

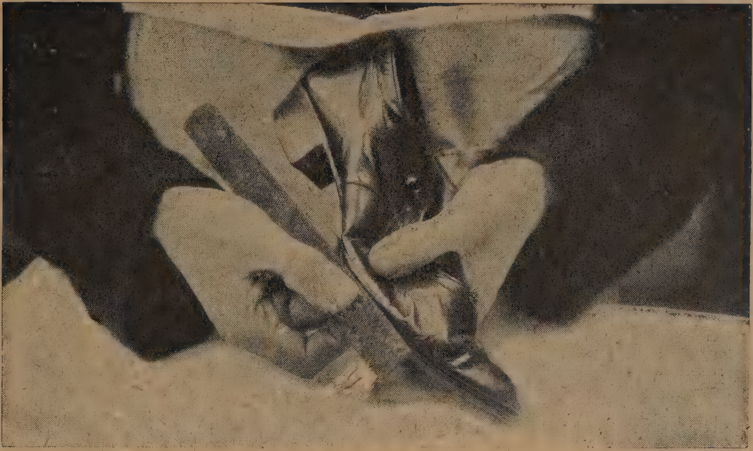


Fig. 33.—Rasping the Forepart of a Shoe: Using the Rough Side of the Rasp

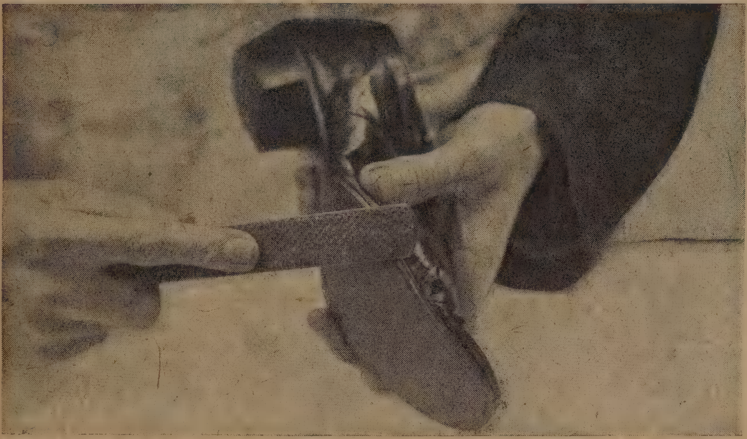


Fig. 34.—Rasping the Forepart of a Shoe: Taking Off the Burr with Smooth Side of Rasp

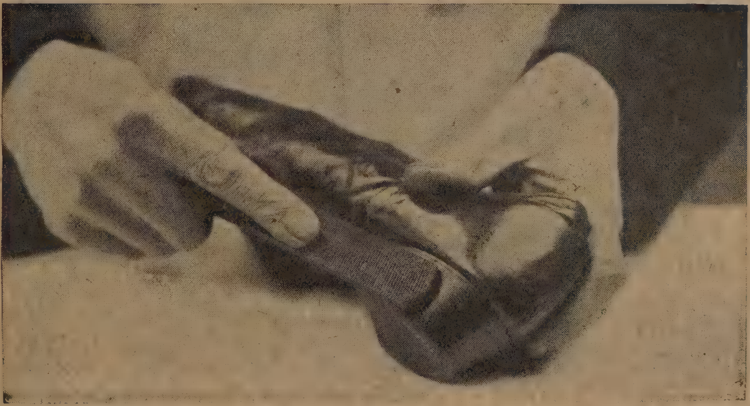


Fig. 35.—Rasping the Heel of a Shoe: Using Round Part of the Rasp

heel next to the worker, and bottom to the right. Using the flat rough side of the rasp (see Fig. 33), begin the rasping at the joint, working right round to the joint at the other side. Press the upper back with the left thumb as proceeding, to keep the upper from being damaged by the rasp. Having rasped the edge level, a "nap" or "burr" will be noticed on the edge of the bottom all the way round. File this off with the smooth side of the rasp, as in Fig. 34. Then turn the boot with the toe towards the worker, and rasp round the heel, using the rounded rough side of the rasp (see Fig. 35), finishing up with a few rubs with the flat rough side. File off the "burr" round the edge of the top-piece.

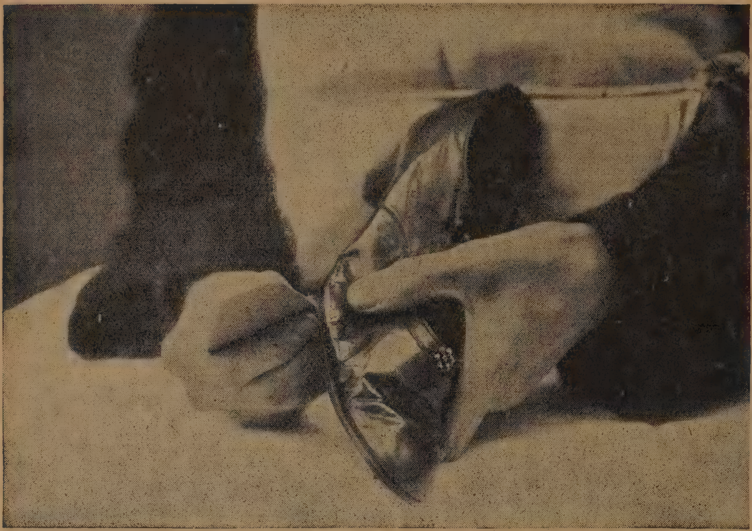


Fig. 36.—Scraping Forepart or Sole Edge

Now hold the boot with the toe away from the worker, hold the scraper between the thumb and forefinger of the right hand at a slight angle, and, using the narrow end, begin scraping the edge at the joint, as in Fig. 36. When the toe is reached, make a clean movement quickly round it, so as not to jag the edge, and proceed scraping down to the farther joint. Now turn the boot with the toe next to the worker, and, beginning at the heel corner, scrape round the heel, using the widest end of the scraper as in Fig. 37, so as to cover

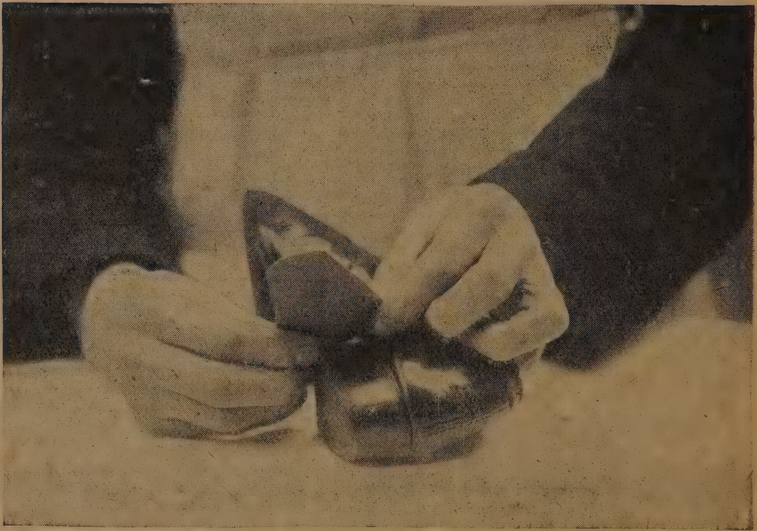


Fig. 37.—Scraping the Heel

the portion of the heel which has been built up. If the heel is a hollow one, the narrow end of the scraper must be used to get into the hollowed portion.

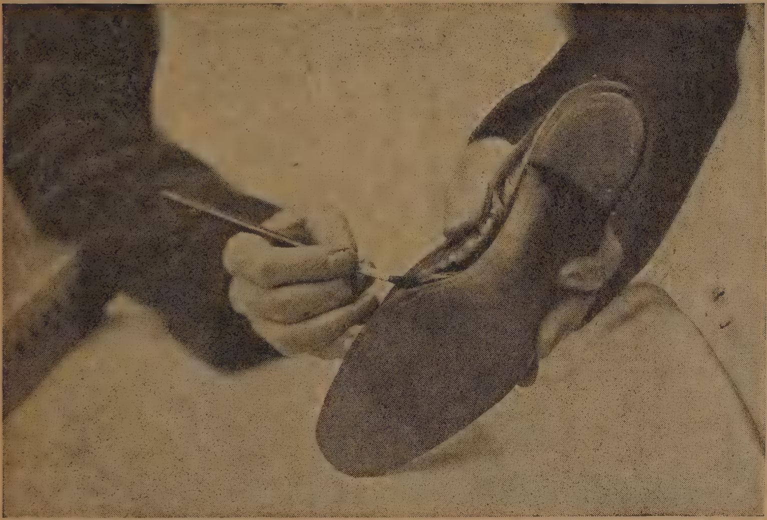


Fig. 38.—Inking the Edges: The Start

After glass-papering the heels and edges, the boots are ready to be put into "colour" or inking. First, with the point of the knife make a mark extending right across the sole from joint to joint, this operation being termed "marking off the waist."

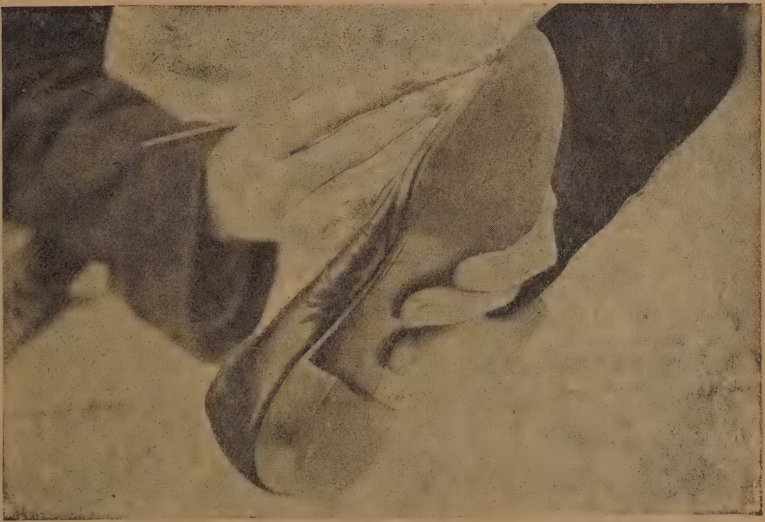


Fig. 39.—Inking the Edges: Turning the Toe

Inking the Edges.—There is a right and a wrong way of holding the boot even for such a minor operation as inking, if it is desired to have a clean bottom without the ink running over the burnishing. Hold the boot, bottom upwards, just under the instep with the left hand, the heel pointing to the left. Hold the ink brush at a slant, bristles upwards, and begin inking at the nearest joint (see Fig. 38), and work up to the toe. A slight turn of the left wrist, and the heel is now to the right hand (see Fig. 39). Proceed inking down to the other joint and as much of the heel as is before the worker. Slightly turn the heel, and ink the back. Now with a turn of the wrist bring the boot back to its first position, and ink the remainder of the heel. Tilt the boot toe upwards slightly, and ink across the waist—that is, the portion of the sole previously marked off with the knife. The position in which the boot is held, together with the resistance formed by the scratch mark, will prevent the ink from running over the forepart. Ink the waist proper below the sole. Turn the wrist, bringing the boot toe next to the worker, and ink the inside or "breast" of the heel, and the operation of inking is complete. It will be noticed that in no part of the operation has it been necessary to release the hold of the boot. Lay the boot aside for the ink to dry.

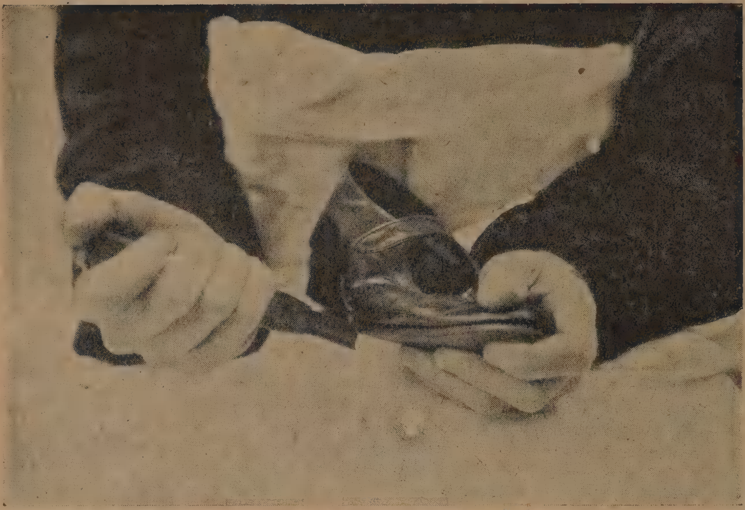


Fig. 40.—Setting the Edge

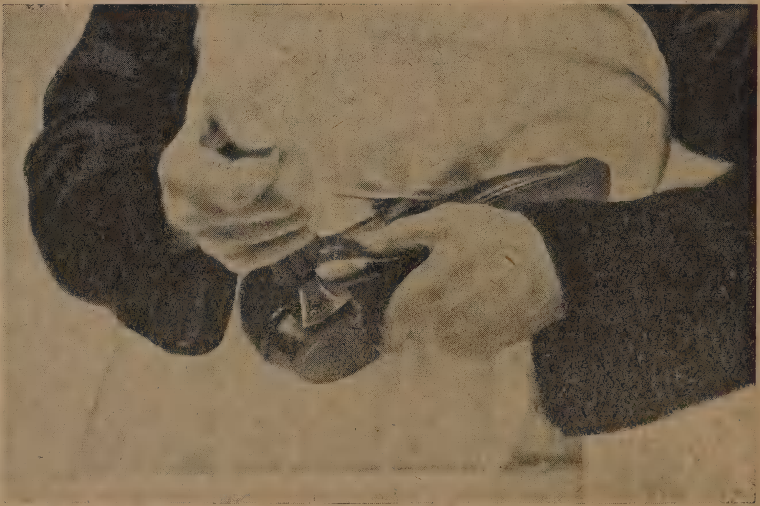


Fig. 41.—Burnishing the Heel

Setting the Edges.—When the ink is dry, the first operation is "setting the forepart"—that is, the edge of the sole. Hold the forepart iron over a gas jet until it is hot. To ascertain the right heat, drop a little water on the face of the iron. If the water dries up slowly, the iron is at the right heat; but if the water dries up rapidly, the iron must be allowed to cool off a little, as otherwise the sole edge would be burnt. One side of the iron has a flange or projection, termed "the guard" (see Fig. 29, p. 111). Place the boot on the left knee on edge, with the upper nearest to the worker and the toe of the boot to the left. Place the iron, held in the right hand, on the sole edge, with the guard inserted between the upper and the welt, and press the guard firmly against the welt. Lay on as much pressure as possible, and move the iron forwards towards the toe, but do not lift the iron from the leather. Whilst ironing round the toe, at the same time turn the boot over, bringing the toe to the right hand, and continue down to the other joint.

Replace the boot in its first position with the toe to the left. Place the iron at the joint; but this time let the guard of the iron be placed against the bottom edge, and iron round as before.

The operation of setting the edge with the forepart iron is illustrated by Fig. 40.

Now hold the heel-ball to the flame to slightly melt it, and rub a little heel-ball round the sole edge. Re-heat the forepart iron, and again "set" the edge exactly in the same manner as before.

Burnishing Heel and Waist.—The boot is now ready for burnishing the heel and waist, which is a simpler operation than setting the edges. Hold the boot on the left knee, with the heel to the right hand. Having heated the burnishing iron, begin ironing at the corner of the heel, moving the iron quickly upwards and downwards between the bottom of the heel (termed the "seat") and the edge of the top-piece (see Fig. 41). Continue this movement all round the heel to the opposite heel corner. If the heel is a square or flat one, the iron will be held quite flat to the leather; but if the heel is military or hollowed, the iron will need to be held at an angle, using the edge of the face of the iron so as to get well into the hollow.

Next hold the boot bottom upwards, the toe pointing away from the worker, and iron the waist portion of the sole and the waist itself. Apply heel-ball, and re-iron.

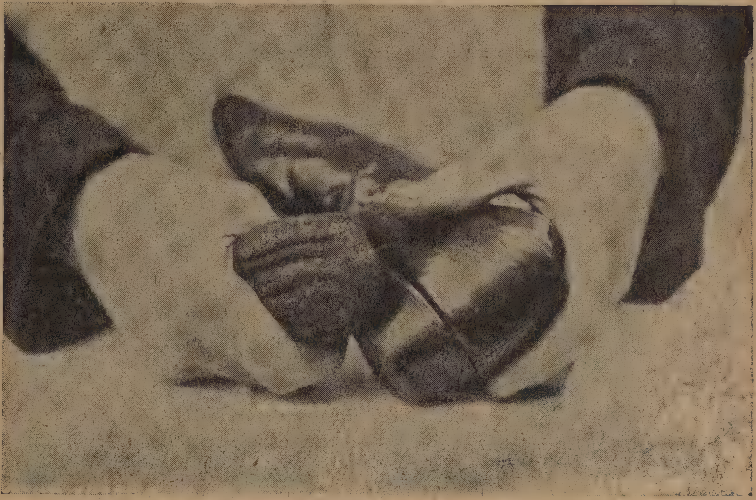


Fig. 42.—The Final Operation; Rubbing Off

Rubbing Off.—This, the final operation, consists in removing the surplus heel-ball and obtaining a bright polish. Take a piece of cloth of close texture, but not loosely woven, because any fluff or nap will adhere to the heel-ball and result in a streaky polish. Wrap this cloth firmly over the right thumb, and rub with pressure round the heel, edge and waist (see Fig. 42), until the wavy appearance caused by the melted heel-ball has disappeared. Now rub off again with a lighter touch, and finishing is completed.

Aquariums, and How to Make Them

THE base and framing of an aquarium may be of any one of a number of different materials, and in this chapter will be described methods of building tanks with wood frames, angle-iron frames, zinc frames, and cement sides.

Wood-framed Aquarium.—For constructing the wooden-frame aquarium shown by Figs. 1 to 3, teak is very suitable. The aquarium is 1 ft. 6 in. long, 1 ft. wide, and 1 ft. deep, and the four posts are 1⅛ in. square when finished. These posts are also suitable for an aquarium 2 ft. long, 1 ft. 3 in. wide, and 1 ft. 3 in. deep. The materials should be planed up square to their respective sizes, and the four posts set out for mortising, the form of which is shown in Figs. 4, 5, and 6. It will be noticed that the mortises at the top and bottom are similar, but are nearer the outsides of the posts, which allows of a wider and longer tenon, and at the same time does not interfere with the rebates.

Next set out the rails for the tenons, the stock of the gauge used for mortising being altered for ⅛ in., as it will be seen that the posts stand forward ⅛ in. beyond the face of the rails. The tops and feet should be turned before mortising. When the mortises and tenons are made, fit the pieces together, and number the joints whilst so fitted to prevent mistakes; also mark the edges that have to be stop-chamfered and those to be rebated for the glass. Then gauge the rebates for the posts, as shown in Figs. 6 and 7. The rebates for the rails are shown in section by Fig. 8. The sections of the top and bottom rails are similar, with the exception that there is an additional chamfer on the inside edge of the top rails. All the rebates should be about ¼ in. deep; those of the posts are stopped at the top and bottom as shown at A (Fig. 6). A cutting gauge is very useful for cutting the rebates for the posts, whilst a rebate plane can be used for rebating the rails.

When each piece has been chamfered, smooth up and fit the joints together with varnish whilst wet; for further security the upper joints should be held with 2¼-in. screws. It will be noticed that, as shown in Fig. 4, these screws are not directly in the centre of the rail, one being above it and the other, which is at right angles, below it. The bottom rails and posts can be secured together by a brass plate at each corner, which screws to the under-side of the rails, as shown in Fig. 9, which gives a view of the bottom angle, looking up.

The aquarium will be improved in appearance if sixteen spherical buttons are fixed to hide the screw holes, as shown.

The glass for the bottom, sides, and ends should be of a thickness of from $\frac{3}{16}$ in. to ¼ in., and set in the rebates with cement. A good cement for this purpose is a mixture of red-lead and white-lead mixed with a little gold-size. The edges of the glass should be previously coated with gold-size so as to make the cement adhere better to the glass; only sufficient cement to make a firm joint should be used. A more water-tight joint can be formed in the four vertical angles by fixing a small strip of wood inside, as shown at B (Fig. 7).

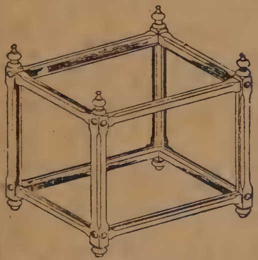
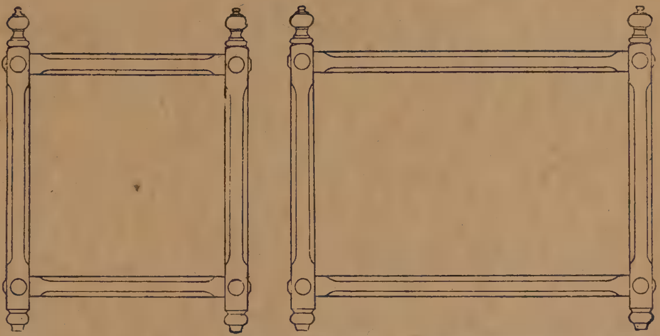


Fig. 1.—Framework of Aquarium


Figs. 2 and 3.—End and Side Elevations of Aquarium Framework

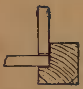


Fig 8 —Section Through Bottom Rail

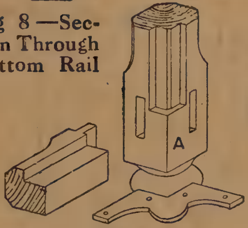


Fig. 6

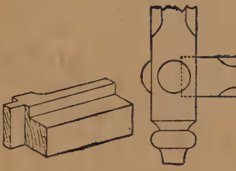


Fig. 5

Figs. 5 and 6.—Details of Joint at Bottom Corners

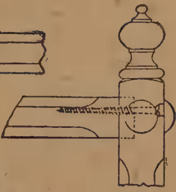


Fig. 4.—Top Joint

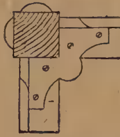


Fig. 9.—Underneath View of Bottom Corner Joint, etc.

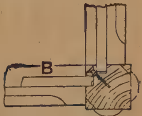


Fig. 7.—Section Through Angle Post

Aquarium with Aerating Apparatus.—Figs. 10 to 12 show a small aquarium with apparatus for the aeration of the water. The material required is as follows: Base of tank, oak or basswood, 2 ft. 3 in. by 1 ft. 6 in. by 1 in. thick. Corner posts: Four pieces $\frac{1}{2}$-in. by $\frac{1}{2}$-in. light angle iron, each 1 ft. 6 in. long; four pieces oak or basswood, $1\frac{1}{2}$ in. by $1\frac{1}{2}$ in. by 1 ft. 3 in.; twelve brass screws and sockets as in Fig. 13; twelve $\frac{5}{8}$-in. screw nails. Glass: Two pieces, 2 ft. long by 1 ft. 3 in. wide; two pieces, 1 ft. 3 in. long by 1 ft. 3 in. wide; and 2 lb. of putty. For the aeration apparatus will be required 1 ft. of $\frac{1}{2}$-in. glass tube, 6 ft. of $\frac{3}{16}$-in. glass tube, two corks, 1 ft. of rubber tubing, and a piece of wood for the regulator C (Fig. 17).

In making the tank (Figs. 10 to 12), first prepare the base or sole piece, which is grooved to receive the glass sides and ends of the tank. The groove could be partly formed with a plough, but would require to be completed with the chisel. In moulding the corner of the sole, begin by running the moulding plane on the ends, and then repeat the same operation on the front and back edges. Where the worker considers the handling of a moulding plane a difficulty, a splay might be substituted for a moulding.

The angle posts should now be marked off on the sole piece and the sizes of the glass obtained. In making the inner part of the post the light angle iron should be bored for the screws and sockets (Fig. 13) which fix the glass. Then the ends of the angle iron should be cut, so that the sides can be turned up as shown in Fig. 14 for fixing to the sole piece (see Figs. 15 and 16).

In preparing the outer part of the post

plane the wood to 1½ in. square, and set off the 1-in. by 1-in. check, which is to be cut out of the inner angle (see Fig. 16). The check can be cut out with the tenon saw, and finished with a rebate plane.

The tank is now ready for putting together. Screw the inner angle posts to the sole piece (see Fig. 15), and fit the glass in position (see Fig. 16). The glass should then be removed, and a light bed of putty (or of the cement already given) put on the angle post and in the groove of the sole piece. The glass should then be finally put in position ready for fixing. Next take the outer angle post, and on the inner checks put a bed of putty, and fix in position, as in Fig. 16, using three screws and sockets on each corner post. The method of aeration is to drive the air bubbles into the tank by pouring water from a height above. A (Fig. 17) is the reservoir, which need not be specially made, a glass or earthenware jar being very suitable. The regulator C acts by pinching the rubber connecting-tube with two flat pieces of wood, which can be screwed together or farther apart by means of two screws (see Fig. 18). Its purpose is to regulate the flow of water from above, and it should be so adjusted that the water drips rapidly.

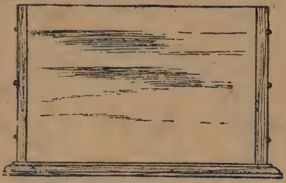


Fig. 10

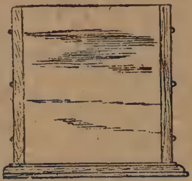


Fig. 11.—End Elevation of Aquarium

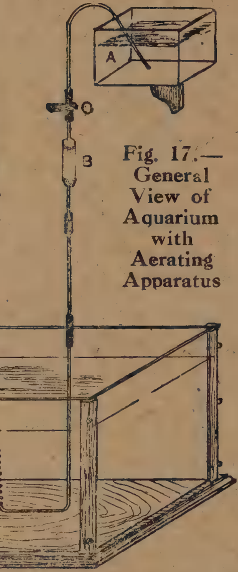


Fig. 17.—General View of Aquarium with Aerating Apparatus

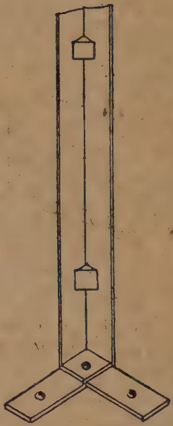


Fig. 14.—Angle Post

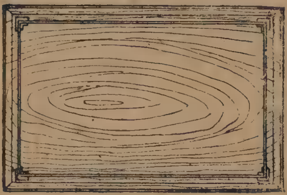


Fig. 12

Figs. 10 and 12.—Elevation and Plan of Aquarium

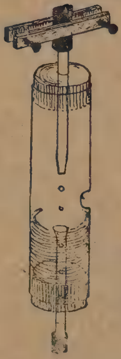


Fig. 18.—Glass Receiver and Regulating Valve

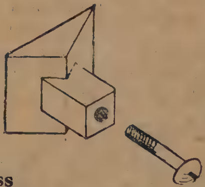


Fig. 13.—Screw and Socket

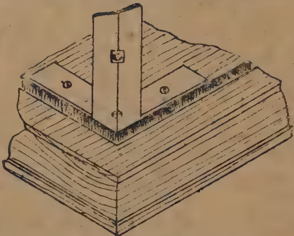


Fig. 15.—Joint of Inner Post and Sole Piece

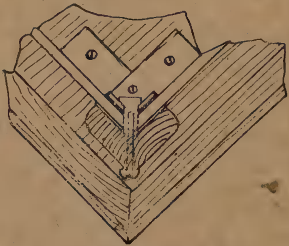


Fig. 16.—Detail of Corner Piece

The portion B of the apparatus is the

most important. It consists of a 4-in. length of $\frac{1}{2}$-in. bore glass tube, through the side of which a hole has been filed. The bored corks on the ends must fit tightly, and the finely drawn, pointed glass tubes should be so adjusted that the continuous drops of water from the upper strike on the opposing points below. The succession of air bubbles thus imprisoned are driven downwards, along the bent tube, which is also drawn to a point, and so into the aquarium. The whole apparatus need not be more than 4 ft. long. The aerator B should be placed near the reservoir to get the best results, and all the tubes should be kept clean. The whole of the aerating apparatus is easily made with the aid of a file and a bunsen burner.

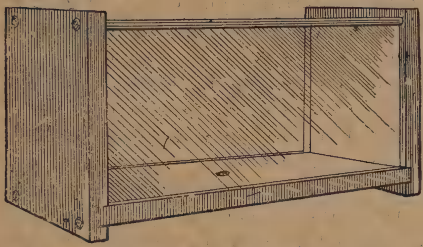


Fig. 19.—Cement-sided Aquarium

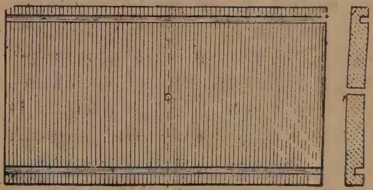


Fig. 21.—Bottom of Aquarium

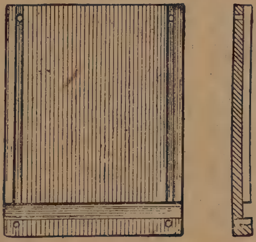


Fig. 22 —End of Aquarium

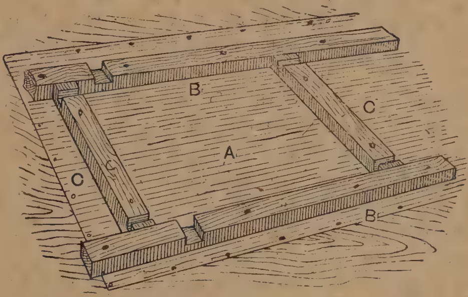


Fig. 20.—Mould for End of Aquarium

To start the apparatus, fill the tank to the level required ; then fill the reservoir from the tank. Now pinch the rubber connecting-tube tightly, and exhaust the siphon of air. Place the siphon back into the reservoir, and gradually release the connecting-tube until the water begins to drop. By occasionally replenishing the reservoir from the tank, the apparatus will work for an indefinite length of time.

Making a Small Cement-sided Aquarium. — An aquarium such as is shown by Fig. 19 is usually made of slate with glass sides, but for the ends and bottom, cement slabs will, if carefully treated, answer equally well. The one here described measures inside 1 ft. $5\frac{1}{4}$ in. by $8\frac{1}{4}$ in. by $9\frac{3}{4}$ in., and will comfortably hold 3 gal. of water, besides the ornamental rockery, etc.

For the back and front, two squares of plate glass, each 1 ft. 6 in. by 10 in., will be required. The four tie rods are 1 ft. $7\frac{3}{4}$ in. long, each end being threaded and fitted with a washer and nut. The bottom and ends are moulded in a frame nailed to the bench or a good stout board (see Fig. 20). Use good portland cement mixed with clean sand in the proportion of 1 part of cement to $2\frac{1}{2}$ parts of sand, and mix together well before wetting. Tack an old piece of sheet zinc or iron A about 2 ft. by 1 ft. 2 in. to the bench or board on which the parts are to be made. On the top of this nail two pieces of 1-in.

board B about 1 ft. 8 in. long, 10 in. apart, and between them, across at each end, two other pieces C so as to form a tray 1 ft. 6 in. by 10 in. and 1 in. deep. Cut a notch in each short piece, ½ in. wide, ½ in. deep, and ½ in. from each end, as shown in Fig. 20. Then plane up a straightedge of ½-in. stuff 2 ft. long and 2 in. or 3 in. wide, so that it will fit quite slack in the notches.

The cement and sand can now be mixed and the mould filled, using as little water as possible. With the straightedge the top can be levelled and the groove for the glass pressed in, using the notches as a guide. A hole can be made in the centre of the slab for the overflow pipe or a fountain (see Fig. 21). If not required it can be closed with a cork. Having made the surface nice and smooth, and sprinkled on a little dry cement, it can be left to set and dry, which will take at least three weeks.

For making the ends (Fig. 22), move one of the splines C (Fig. 20) so that the mould is reduced to 1 ft. 1 in. by 10 in., and cut two more notches 1 in. from the bottom, ½ in. deep, and 1⅛ in. wide, as shown at B (Fig. 20). Trim up a piece of stuff to form the groove for the bottom slab, which must be rather more than 1 in. wide. The mould is filled, grooves formed, and the holes pressed in for the four tie rods. The part of the narrow groove which will be below the bottom should be filled in, otherwise it will weaken the corner.

When the two ends are made and dried, the tank can be put together. First coat inside the grooves and the ends of the bottom slab with thin white-lead paint, and when dry, put all together with putty made of half common putty and half white-lead, or use the cement already given. Do not use all white-lead, or it will cause trouble when a square of glass has to be replaced. The tie rods should be painted, a galvanising paint answering very well for the purpose. When put together, it should be left for a day or two to allow the putty to set before being painted. The only painting required inside will be a strip of white in each angle about ¼ in. wide, and one coat will be sufficient. Outside it can be painted in any colour to suit the surroundings.

If the appearance of the tie rod and top edge of the glass is considered unsightly, it can be covered with a piece of brass tube, similar to that used for the top edges of leaded-glass blinds.

Before using the tank for fish, fill it with water and let it stand a day or two. Empty it out and repeat a few times; there will then be no taint from the paint and putty.

Zinc-framed Aquarium.—The frame of the aquarium shown by Fig. 23 is of angle zinc. Take a strip of this material and cut off four pieces of a length equal to the height of the frame, and cut triangular pieces off the bottom corners at an angle of 45°, as shown in Fig. 24. Cut off two lengths each for the sides and ends of the base, and cut triangular pieces off both ends of each length at the same angle as for the uprights. File each end where it is to be joined, so that when the pieces are fitted together they mitre accurately. Now place the four pieces forming the base of the frame in position, solder them together at the corners, fit the uprights in each corner, and solder them in position along the mitre lines. Then take a length of zinc moulding of any shape, and cut lengths from this so that they fit over the top end of the frame, and mitre at the corners. Solder the moulding together at each corner on the inside, slip it over the top ends of the uprights, and solder them flush with the top edge of the moulding. Cut some pieces of sheet-zinc, making the width a little less than the width of one side of the angle zinc, and the lengths equal to those of the angle pieces in the frame. Fold each length of zinc up square along one side so that the seating formed will be deep enough to carry the glass, as shown by Fig. 25. Solder these pieces inside the uprights and along the sides forming the base, the position being indicated by Figs. 25 and 26, which are sections on lines A and B (Fig. 23).

Another method of making the frame is shown by Fig. 27. The uprights are formed by bending strips of sheet-zinc to the section shown, and soldering them to a length of zinc tube to form the corners.

A third method is to form the frame of zinc tube, two small split tubes being soldered to a larger one to form the corners, as shown in Fig. 28.

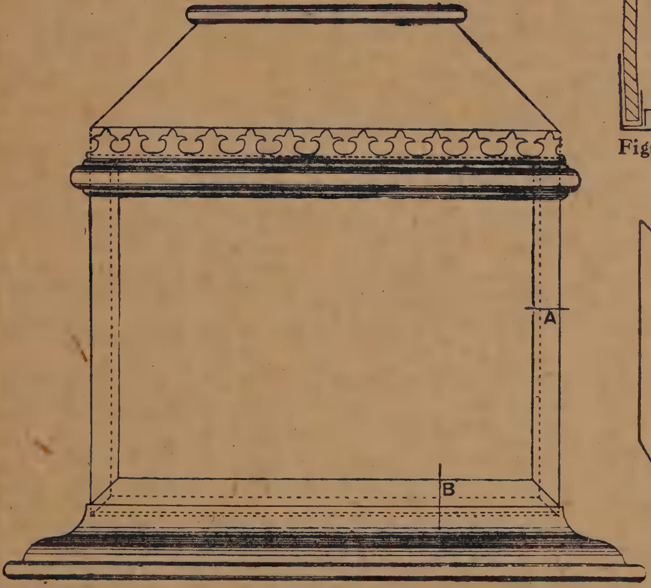
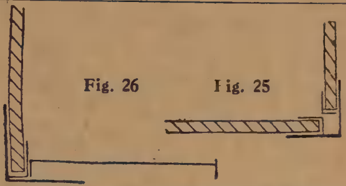


Fig. 23.—Zinc-framed Aquarium



Figs. 25 and 26.—Sections Through Aquarium Frame

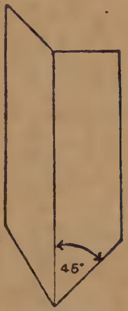
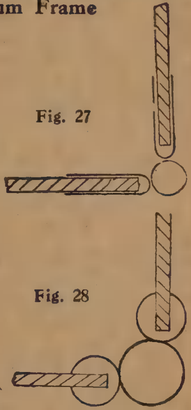


Fig. 24. — Zinc Piece for Bottom Corners



Figs. 27 and 28.—Sections Showing Other Methods of Making Frame

The bottom should be cut large enough to allow a quarter edge to be set up square on each of its sides, and made so that it fits closely against the back of the pieces soldered to the angle zinc to carry the glass. Place the bottom in position (Fig. 26), and solder round soundly and neatly.

To make the base, cut lengths of moulding of the required size and saw off the ends on a mitre block, so that when the four pieces are placed in position and soldered together, the base of the zinc frame will fit closely in the opening formed by the top of the moulding. Now solder the angle zinc to the moulding in the position shown by the lower dotted lines in Fig. 23. Clear off all spare solder with a scraper, and smooth the soldered parts with emery-cloth.

The ornamental stamping for the top is next bent to fit the moulding, and, where fitted, tacked on the inside with solder to the moulding.

A top for the aquarium may be made of perforated zinc, with beading round the rectangular opening at the top to the shape shown, and with the base made of a size to allow it to fit inside the stamped border and rest on the top end of the uprights.

How to Make a Mattress

A MATTRESS may be described as a cloth case, box-like in form, filled with wool or horsehair, or a mixture of both, and also occasionally with alva, which is a seaweed imported from the Baltic, and which, if used green, is liable to become mildewed and to breed grubs.

If the worker were setting up a small business he would need two rather expensive appliances—a carding machine or "mill," and a sewing machine, the latter being required for machining up new cases. The carding machine should be of modern type, and not one of the old heavy patterns, which require a great deal of power to drive. A good, useful machine can be purchased new for about £10, but a saving can be effected if a second-hand one can be obtained. The sewing machine should be of a heavy "manufacturing" type. For the amateur's purposes, however, the fillings could be broken up with hand cards instead of with a machine, and, if he particularly wished to avoid the heavy sewing-machining, he could obtain the mattress cases ready made from manufacturers of bedding.

The Ticking.—The materials of which mattress cases are made are of various kinds, that in greatest demand being imported from Belgium and known as Belgian ticking; its surface has a fine lustre, which is said to be unsurpassed by the manufacturers of any other country, although Manchester is sending out a material which, if not possessing quite such a lustrous surface, is probably more lasting. Cheap tickings cannot be recommended for hard wear, as they are liable to fray out at the seams. A material which, although at one time in universal demand, is but little met with nowadays, is the greyish blue tartan pattern stuff known as plaid ticking. Ordinary blue and white British-made ticking, which is so much used for making the cases of feather beds, bolsters, and pillows, is sometimes used for making the cases of good quality hair mattresses, the tick usually being of the linen variety.

The Filling.—The stuffing materials—or, as they are termed by upholsterers, "fillings"—require careful consideration. All upholstering materials should be pure and clean, and especially is this the case with mattress fillings. There are on the market a large number of different qualities of fillings, the cheapest of which was, until recently, made from unwashed rags, torn asunder in heavy mills; a material of this description is wholly unfitted for use in bedding. Shoddy is made from rags, carpet, etc., and if thoroughly washed and purified, forms an all-round filling for cheap work. Next in the upward grade are the ruggings, which are of various colours and mixtures, and are the rougher kinds of cotton and wool. Linseys, a trifle dearer than ruggings, are softer than the latter and consequently give better results when used as fillings.

Pure wools are, of course, the best materials for filling, but their price prohibits their use in any but the best work. Horsehair enters largely into the bedding trade as a filling for mattresses, either alone or in conjunction with wool, and where the two materials are used in combination, they can be either mixed, or the mattress can be "cased hair" or "cased wool," according to requirements.

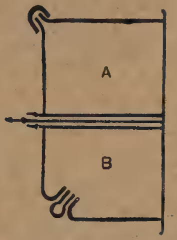


Fig. 1.—Bound and Welted Seams

Bedstead Sizes.—The standard lengths of bedsteads are 6 ft. and 6 ft. 6 in., the latter size being most common in those of recent manufacture, while the older types are mostly 6 ft. long, the widths being as follow: Small single, 2 ft. and 2 ft. 6 in.; medium single, 3 ft.; large single, 3 ft. 6 in.; small double, 4 ft.; full size, 4 ft. 6 in.; and outside full size, 5 ft.

Making the Case.—The first thing to make is the case, or tick, and this must be larger than the actual finished mattress, as when the tufts are pulled in they take up a certain quantity of material. An allowance of 2 in. to every 3 ft. should be made in cutting up the ticking. Thus for a mattress requiring a finished size of 6 ft. by 4 ft. 6 in., the tick should measure 6 ft. 4 in. by 4 ft. 9 in., larger and smaller sizes being made in proportion. The border—that is, the ends and two sides—is usually 4¼ in. deep, although a depth of 5 in., and even more, is sometimes allowed, but these latter thicknesses are usually made to order. The form of mattress tick in most general use is the "bordered and bound," and in making this case it is simply necessary to butt the two edges of the material together, back to back, and to bind them with tape known as "bedlace," sewing the lace and material together, with the tick right side out. A more elaborate and comparatively little used method of finishing the borders is that of bordering and welting, and this has to be done on the wrong side and turned. In welting, bedlace is not required, a "piping" or seaming made of strips of the ticking about 1 in. wide being used; this is doubled over thick string or "laid cord" to give an edge, the seaming being roughly tacked before the top and bottom of the case are machined to it. A corner of a mattress case is shown at Fig. 1, which outlines the difference between bound or "strapped" ticks A and welted ticks B. The black lines represent the covering material. An opening should be left in the end of the mattress case sufficiently large to admit of the stuffing material being inserted and worked level.

Stuffing.—The quantity of stuffing required to fill an overlay depends somewhat on the class of material used, and to some extent on the firmness desired. A good average weight of stuffing is about 10 lb. to the foot in the width, 6 ft. long with 4¼-in. borders. Overfilling a mattress is almost as bad as underfilling, and in the former case the article soon becomes lumpy and consequently uncomfortable to lie on, although much depends on the class of the stuffing material.

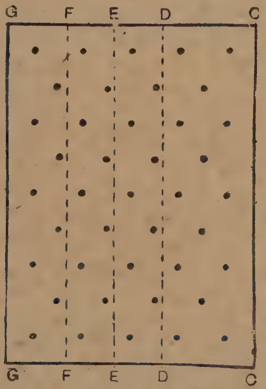


Fig. 2.—Mattress Tufting

To stuff a wool mattress, get the filling well carded and insert it in the opening at the end. Some workers prefer to insert the whole of the stuffing at once, and others insert it by degrees, working it into position as the filling proceeds. Whichever method is followed, the corners and edges should be well stuffed previous to closing the tick, as when the hand cannot be got inside, it is difficult to regulate the stuffing. The mattress at this stage should be considerably thicker than the height of the actual borders, as the tufts depress the stuffing to some extent, and even when the work is finished the actual thickness should exceed the border height by quite 1½ in.

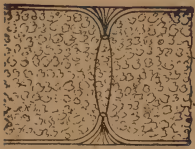


Fig. 3.—Section of Mattress, Showing Tufting Strings

Tufting.—The operation following the stuffing is that of inserting the twines which hold the tufts, these latter being inserted after the stitching is done; the reason for this is that in turning over the mattress the stuffing material will not move from its correct position once the stitching is done. The positions of the tufts are given in Fig. 2, which shows their arrangement for various sized mattresses, their places being marked on the tick by sticking tacks into the material, withdrawing these as the twine is put in. The dots in the rectangle C C D D show the arrangement for a 2-ft. and 2-ft. 6-in. overlay, those in C C E E for a 3-ft. and 3-ft. 6-in. overlay, those in C C F F for a 4-ft. overlay, and C C G G shows the arrangement for a 4-ft. 6-in. or 5-ft. overlay. At each of the points marked, run the mattress needle—which may be 10 in. or 12 in. long and should be filled with good quality upholsterer's twine—through the overlay from the top, bringing the needle and twine out underneath and re-inserting the needle about ⅜ in. away from the point where it came out. The needle and twine is pulled through to the top, a slip-knot being made in one end, and the twine pulled moderately tight, but not so tight as to cut the tick (see Fig. 3).

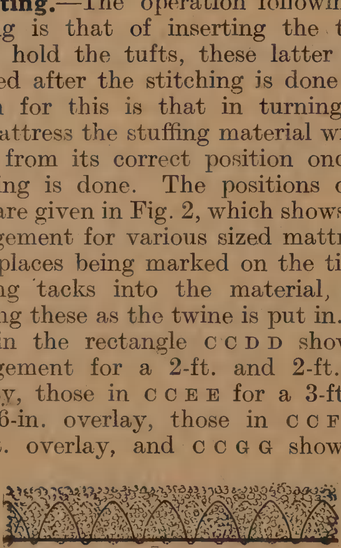


Fig. 4.—Blind-stitches

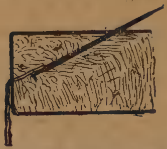


Fig. 5.—Making the Blind-stitch; Position of Needle

Blind-stitching.—Before putting in the tufts, which are circular pieces of leather with a serrated edge and a couple of slits in which the twine engages, the mattress must be blind-stitched all round. The principle of the blind-stitch is shown by Fig. 4, and the method is as follows: insert the needle in the top of the mattress, making a bow in one end of the twine in order that it will not pull through, and draw the needle through the border, pulling it right out and re-inserting about a ¼ in. farther along, so that the twine can get a sufficient hold to enable it to be pulled tight and the stuffing material thus drawn towards the edge of the mattress. On the re-insertion of the needle, it is taken through to the top of the mattress (see Fig. 5) and drawn through to about three parts of its length, the twine remaining on the inside of the tick, and the needle brought out on the edge or surround again about 2 in. from the last stitch. This operation is repeated until the whole of the mattress is blind-stitched round, after which it is turned over and the other side stitched in the same way. When the last stitch has been made, the twine is brought through the same hole it was started in and the two ends of twine tied together, the knot being pushed through the tick. As the mattress is now, the slip-knots of the tufting twines are on the underneath, and the tufts should be put in all the uppermost loops, previous to turning it over, when the remaining tufts can be put in, the knots pulled tight and tied, and the free ends cut off.

Hair Mattresses, etc.—The method of working up a hair mattress is similar to that of wool-stuffed mattresses, excepting that the springy nature of horsehair renders it necessary to insert the filling in small lots, working it close together with the hands in the form of balls, otherwise it will be impossible to get the mattress uniformly stuffed. Hair and wool can be used mixed if desired, the hair preventing the wool from clogging together as quickly as if it were used alone. For the same reason mattresses are made cased with either hair or wool, "cased hair" work having wool packed between two layers of hair and "cased wool" being the opposite.

Another Method of Making a Mattress.—The making of a stuffed wool mattress 6 ft. 6 in. long by 4 ft. 6 in. wide and 5 in. thick, by a different method, will now be described. The mattress has fancy borders, tufted sides and edges, and is reversible. The cutting out should be done first, and for the top and bottom two pieces of Leeds ticking, each 6 ft. 10 in. long by 4 ft. 10 in. wide, will be wanted; for a mattress not requiring to be made reversible the bottom cover would be made of plain cotton or jute cloth. For the borders, have two side pieces each 6 in. by 6 ft. 10 in. and two end pieces each 6 in. wide by 4 ft. 10 in. long; these border pieces are cut from fancy Belgian ticking, and must be cut across the piece so as to throw the stripe in the opposite direction to the top and bottom stripes. To get the length for the side, two pieces must be seamed together and the pattern matched. For the seams about 16 yds. of mattress ribbon will be required. In cutting a mattress case, 1 in. extra may be allowed for each 1 ft. length, and ¾ in. in the width. For example, suppose a 4-ft. 6-in. by 6-ft. mattress is required, it may be cut 4 ft. 8¾ in. by 6 ft. 6 in. When a mattress is to be filled with wool, a trifle less may be allowed, as there is not so much taken up in the tying down of a wool mattress as in the case of hair.

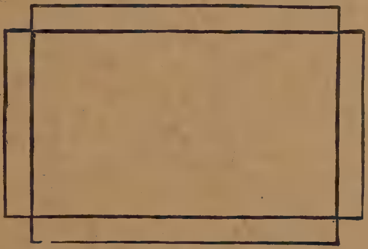


Fig. 6.—Top of Mattress Case

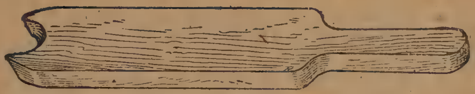


Fig. 7.—Stuffing-stick

To make the case, machine the ticking cut for the top with all four borders on the edge with right side up (see Fig. 6), allowing about ¼ in. from edge to seam; this will throw the raw edges and selvedges on the outside of the case. These are now strapped by the mattress ribbons or bedlace being folded over the seam and machined through the double thickness; some persons baste the ribbons on before machining.

One continuous length of ribbon or bedlace is used for all four edges, and the corners are slightly rounded. The bottom piece is next seamed to the free edges of the borders, with the exception of a space about 2 ft. wide at one end for filling purposes; these edge seams are strapped in a similar manner, and the corners of the borders are seamed inside with a needle and thread. The case is now ready for the fillings, which should be a soft, well-teased wool flock. No definite rule can be laid down as to the quantity required, for this may vary from 40 lb. to 60 lb. for a mattress of this size.

To stuff the mattress case, place it, say, on a flat table top, and, to prevent curling, fasten the end which is stitched with a bradawl or a tack at each corner. Put about 10 lb. of flock in the open end, and work this well into the corners and against the bottom border with a stout stuffing-stick (see Fig. 7). Set up the mattress by beating smartly with the hands, and be careful to have the extreme corners well filled, but not hard. Fill with more flock, using the stuffing-stick freely to lay it even, and set up the borders so that they are square with the top and bottom, as the correct shape of the mattress depends on this being done properly. Continue the stuffing and setting until rather more than half the case is filled, when this portion will be ready for tufting. For tufting, a packet of stamped tufts will be wanted, and also a mattress needle and a ½-lb. ball of best upholsterer's twine. The mattress needle should be from 10 in. to 12 in. long and pointed at each end. The tufts can be set out in straight rows or diamonds, the first method allowing of the mattress being rolled better, although by the second method it will have an improved appearance. Take out the awls or tacks which hold the corners, and see that the case is straight and free from creases. Thread up the needle with twine and pass it through the mattress 6 in. from the bottom edge and at the same distance from the side. Draw out the needle on the opposite side and pass it back again 1 in. nearer the centre, and take hold of both ends of the twine and pull it up. Then place a leather or cloth tuft with the slits between the twine, make a slip-knot at the free end, and draw it tight until the tufts sink about 1½ in. into the stuffing; then tie off securely and cut the thread. The remainder of the tufts are put on in exactly the same way; allow a space of 6 in. between the rows and the same distance between each tuft. Tie all the tufts as nearly alike as possible, or an uneven appearance will result.

The other half of the mattress can be stuffed and tufted in the same manner and the open portion sewn up. The mattress, when completed, should be firm but not hard, and the borders should stand square with the top and bottom.

A WOOD BEDSTEAD AND BOX MATTRESS

The bedstead shown by the photograph (Fig. 8) was made from old pieces of scantling, packing-case wood, etc., the only outlay being for the iron dovetail castings and the white enamel paint. It is a very creditable article of furniture, quite strong and serviceable, and of good appearance, so much so, indeed, that a box mattress was made for it with new materials (see Fig. 9).

The measurements of the bedstead are: length, 6 ft. 6 in.; width, 3 ft.; full height of foot part, 3 ft. 4 in.; full height of head part, 4 ft. The dimensions are given also in Fig. 10, which is an elevation of the foot of the bedstead. The head part is the same, except that instead of the lower panel a narrow rail will do, as shown in Fig. 8, and another quite plain about 1 ft. from the floor.

First get out the legs, to 1¾ in. square, with the corners slightly rounded. The panel piece is of ⅞-in. material, 7 in. wide. This and the rail are mortise-and-tenon jointed into the legs. On each edge of the panel a beading piece is fixed, with glue and two or three sprigs. Before gluing up the joints, the six bars and centre splat must be made, to be mortise-and-tenon jointed in place. The tenons on these need not be more than ½ in. long. For the splat a half pattern in cardboard should be made, as in Fig. 11. The edges of the splat must be rounded the same as the bars. A capping piece is made for the top rail, to be fixed as the heading pieces.

When this much is done, the whole framework may be taken apart, to be put together with glue in the mortise holes and on the tenons of every joint, beginning with the splat and bars. A capping bit is put on the end of the legs, of ½ in. thickness and rounded on the edges; and on the foot ends, somewhat similar pieces are put, but ¾ in. thick, and more of a "thumb" shape.

The ball ornaments were cut from some old turning which happened to be about, and they are fixed with wood dowels. Some of these details are shown in Fig. 12.

With regard to the beading on the panel, the circular centre is half of a curtain-pole ring. It is fixed with glue and fine pins, and the straight pieces were made to the same half-round section and fixed likewise. The ornament on

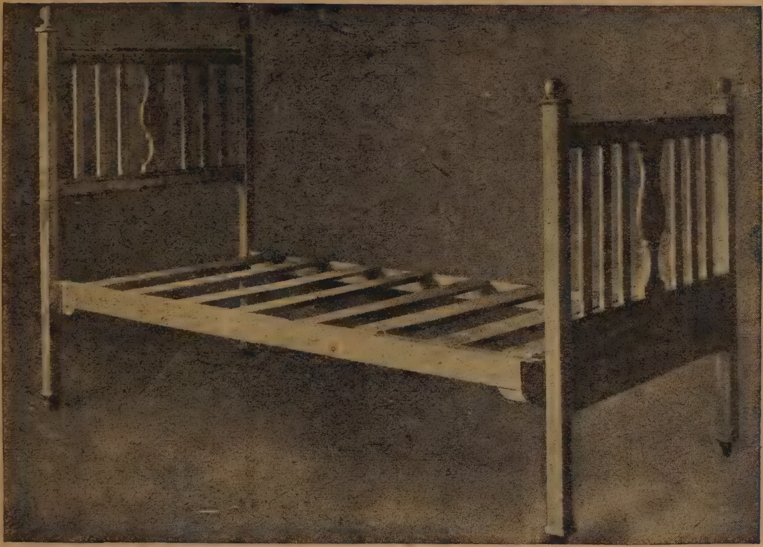


Fig. 8.—Wood Bedstead Finished in White Enamel

the splat is also half a ring, of smaller size ; and inside it is fixed the set-screw ornament of a brass curtain-pole bracket, which, when enamelled, has the appearance of carved wood. The knobs on the head-posts are curtain pole terminals, and there are casters on the feet.

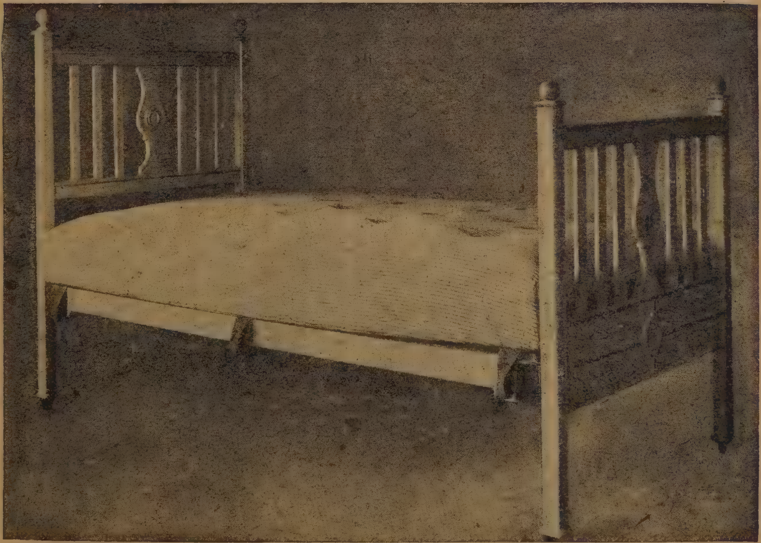


Fig. 9.—Wood Bedstead with Box Mattress in Place

The side rails are of spruce scantling, 3 in. by $1\frac{3}{4}$ in. in section, but a block about 4 in. long is fixed at each end of the underside to increase the width to $3\frac{1}{2}$ in., to take the dovetail castings. These are of malleable iron, and are fixed as shown by Fig. 13, the upper side of the rails being about 1 ft. 4 in. from the floor.

The laths may be of $\frac{7}{8}$-in. material, about $3\frac{1}{2}$ in. wide, the ends being let into the rails, level and about $\frac{5}{8}$ in. on. As they are likely to differ somewhat, it is well to mark them with chisel cuts, numbering them with I's and V's, as in Fig. 14, which is number six. The side rails and posts should also be marked, to get them right without any fumbling. All sharp, square corners of the rails and laths should be chamfered off, and rubbed over a little with glasspaper. All the other parts of the woodwork would be glasspapered before being put together. Any defects or nail-holes must be stopped up with putty, and the work is then ready for enamelling.

It should be given four coats of ivory-white "flat" enamel, allowing a day between each to dry, and smoothing down with glasspaper, finishing off with two coats of glossy enamel.

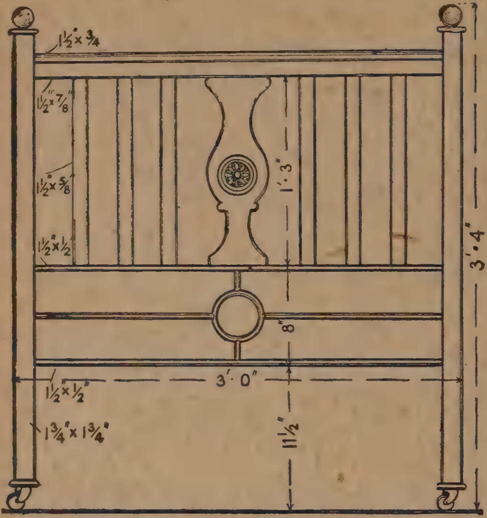


Fig. 10.—Elevation of Foot of Bedstead

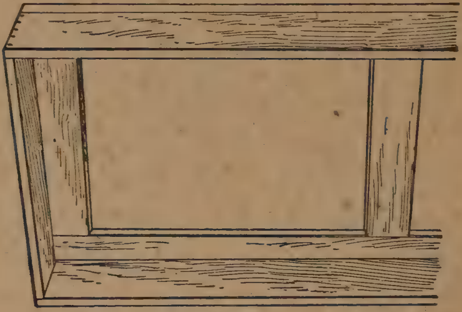


Fig. 15

Fig. 14.—Fitting and Marking Laths and Rails

Fig. 15.—Part of Box for Mattress.

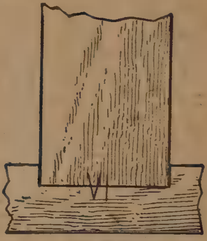


Fig. 14

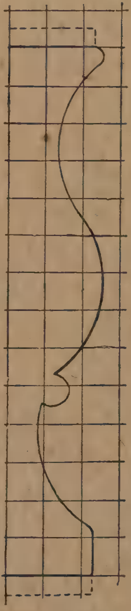


Fig. 11.—Half Pattern of Splat

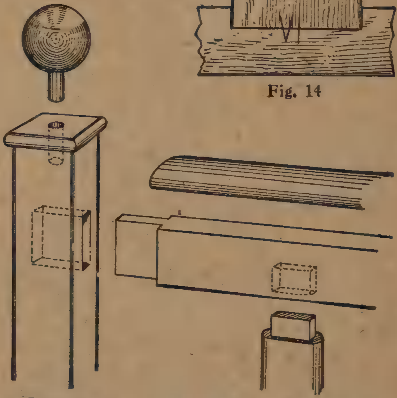


Fig. 12.—Joints in Bedstead Framing

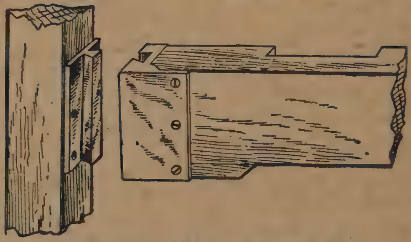


Fig. 13.—Dovetail Castings

Making the Mattress.—The bedstead is now ready for the mattress, which is shown in place in Fig. 9. The box spring mattress has many advantages. It can be made at home by an average handyman; and considering that it is spring mattress and soft mattress in one, lasts considerably longer than a wire mattress, and does not get hard or require remaking as often as a soft one, it is certainly economical. Also, it saves the labour of turning over every day and occasional winding up of the wire, and the precautions against rusting of same. A box mattress will often last from twenty to thirty years without needing repair, which is, perhaps, too long, as it is advisable that it should be cleansed and purified occasionally.

There are different ways of making box mattresses, the one here to be described being fairly simple. The wood frame is made of a size to lie on the lathed bottom even with the outer sides of the rails; but in length it should be about ½ in. from the posts at each end. The wood may be about 4½ in. wide, by 1 in. thick, and consists of three rails mortise-and-tenon jointed to two long rails, one at each end and one central. This is the box bottom frame. Another frame is required to form the box sides, but this is simply four pieces nailed together. They are of the same width and thickness as the bottom frame, which is to be nailed or screwed to them. Fig. 15 shows what it should be like at this stage of the work.

The next thing is to web the bottom with No. 12 English web, six webs put lengthwise first, then the cross webs are woven in and fixed about the same distance apart (see Fig. 16). There are thirty springs required. Special mattress springs are to be obtained, but in the majority of cases (as in this) the ordinary furniture springs are used. They must be placed in symmetrical order on the webbing and frame, their exact positions being shown in Fig. 17. To the wood they are fixed with wire staples at three points, as at A; and to the webbing they are stitched in the way shown at B. The diagonal dotted lines represent a webbing passing over the top coils of the springs, German web being good enough for this. It is tacked on the upper edges of the box sides, an inch or two being allowed to lap over on the outer sides, and is stretched over as tight as possible without overstraining, to pull the springs down somewhat firm. The webs are put on all one way first, then the others are woven in, and they are stitched as were the bottom coils.

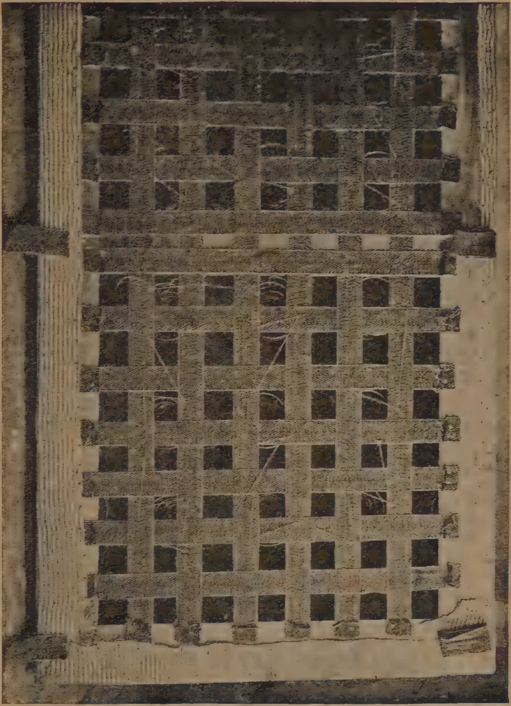


Fig. 16.—Part of Box Mattress Bottom Finished Except for Canvas Cover

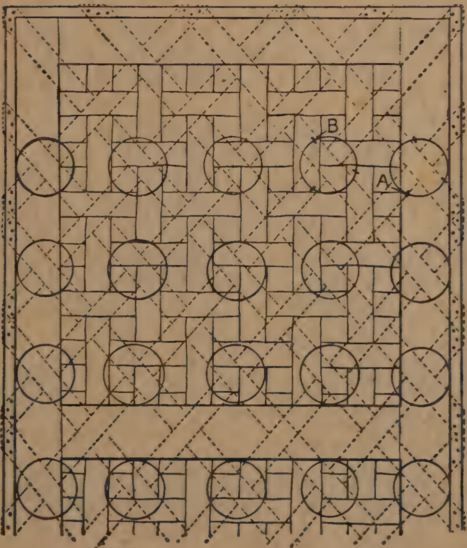


Fig. 17.—Box Mattress Springs and Webbing

The next thing is to stretch over a good quality canvas cover, tacked to the box sides; then it is ready for making the stuffed edges. For these, two strips of canvas must be cut about 1 ft. longer than the box, by 1 ft. wide, to be stitched to the spring canvas about 6 in. on from the edge. About 1 in. of the strip should be turned in for stitching; and when it is done, the other edge has to be turned in and tacked along the top corner of the box sides. It is started at the middle, and when about 2 ft. is tacked, the loose bag-like receptacle must be stuffed full and even. The stuffing in this case is wood fibre. It brings the edge to the shape shown by Fig. 18, and is worked the same to each corner. The end edges of the mattress are treated in a similar way to make it the same all round.

The next process is to stitch the stuffed edges to form the "roll" and make it firm and shapely. This is done in the manner shown by Fig. 19, which shows the needle ready for drawing out. Each stitch may be taken about 2 in. long, and drawn as tight as possible. On the upper side the stitches will appear as in Fig. 20. It is then ready for the stuffing of wool flock. This is distributed over the surface, judging for it to be, when pressed down firmly by the cover, about 10 in. high, inclining to about 8 in. at the edges.

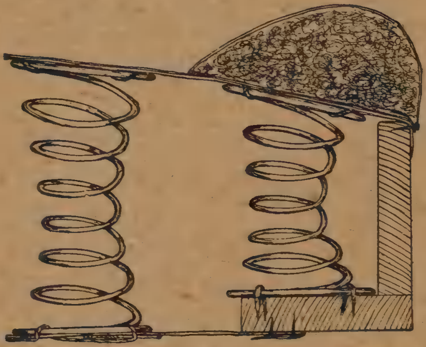


Fig. 18.—Section Through Wood Frame and Stuffed Edge

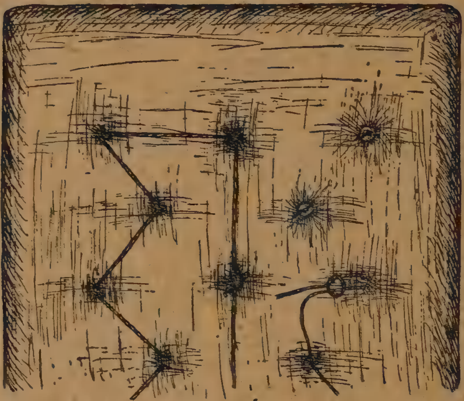


Fig. 22

Fig. 22.—Method of Tufting Mattress

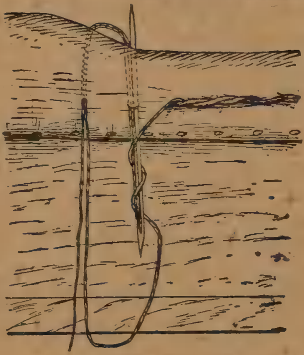


Fig. 19

Figs. 19 and 20.—Stitching Stuffed Edge to Form "Roll"

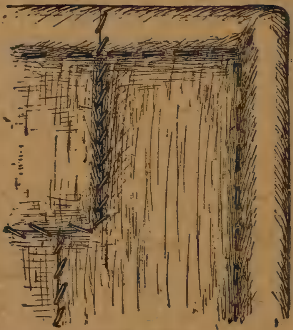


Fig. 20

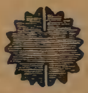


Fig. 21.—Mattress Tuft

When the ticking cover is first put over it is fixed by temporarily tacking along each side of the box, as near as possible to the lower corner; then it is well pressed down, the tacks being pulled out a few at a time, and the cover pulled down tighter and retacked as before. It may then be turned bottom side up to tack down the edges of the cover as shown in Fig. 16, the other tacks being withdrawn and the stuff pulled in a little more. Loops of web, strongly tacked on to handle it by, are also shown. The mattress is then placed in a convenient position for tufting, each end of the frame resting on a trestle or something to suit the same purpose.

Leather tufts are obtainable in small bundles very cheaply, and are of the shape shown by Fig. 21. Their positions on the ticking may be marked in three rows of five each, keeping 8 in. on from the sides and 10 in. from the ends; being then about 12 in. and 10 in. apart. Four 2's are then marked between. In starting to make the stitches for the tufts, the needle, threaded with the twine, is thrust through at the first mark and up again ½ in. from where it entered. Care must be taken that the twine does not get entangled with the springs; then proceed to the next nearest mark, and so on. The stitches need not be drawn very tight. When the last one is done, a slip-knot is made with the end of the twine and loop. A tuft is then put under and the knot drawn tight, being then cross-tied to keep it from slipping. Then the twine is cut off (not too close) and the same method followed at each stitch; see Fig. 22, which shows the last two stitches tufted and tied off, a third being shown with the slip-knot ready for placing in the tuft. A canvas cover must be neatly tacked over the bottom (stretched tight), this completing the mattress.

Altering Gas-fittings to take Inverted Burners

The fact that inverted incandescent burners consume less gas than the ordinary upright kind, while giving a much better illumination, has gained general recognition. Many householders would like to adopt the inverted burners, but their existing fittings are considered unsuitable, or they believe that the alteration will necessitate unsightly and troublesome adapters. It is quite easy, however, by the method about to be described, to fit an inverted burner to almost any upright fitting, without the employment of an adapter.

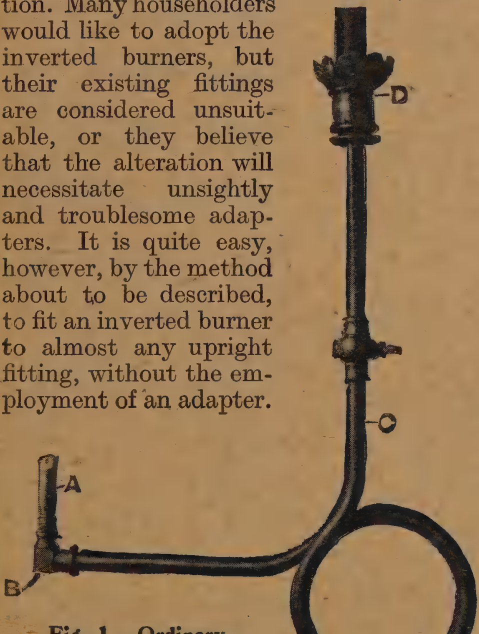


Fig. 1.—Ordinary Pendant Fitting

Fig. 1, for example, shows a pendant fitting. To adapt this, unscrew the burner A and also the globe-holder, if one is present. It will be noted that the burner screws into a small L-shaped junction-piece B. Using a pincers and taking hold of the square portion of the junction-piece, the latter must be unscrewed one half-turn to the left, so that the bush for the burner points directly downward. The inverted burner is then screwed on, as shown by Fig. 2. This obviously brings the globe lower down than the original one, but that can be rectified by pushing the tube C farther back into the upper one D, in which it usually slides like a piston.

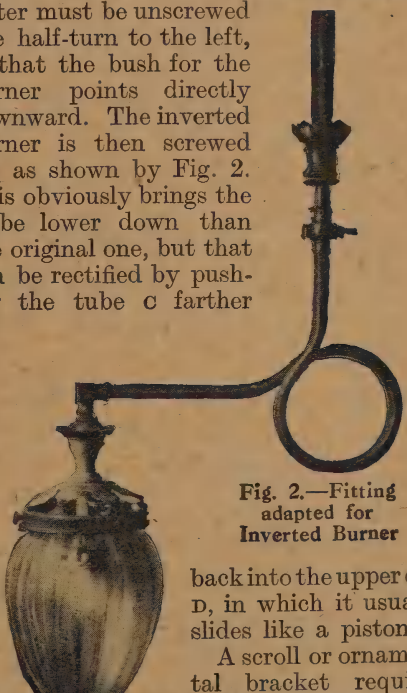


Fig. 2.—Fitting adapted for Inverted Burner

A scroll or ornamental bracket requires different treatment. As shown in Fig. 3 (next page), it is attached by screws to a circular wooden boss. To make the alteration, having removed the globe, the globe support, and the burner, the screws fixing the bracket to the boss are extracted. It may be explained that an unseen tube, forming the gas connection, projects through the boss and screws into the back of the bracket, which therefore is still supported. Grasping the whole bracket, it is gently given a half-turn to the left, thus inverting it. Fresh holes for the screws are then made with a gimlet, and the fitting is again firmly screwed to its boss. The inverted burner—the smallest size, in this case, being best—is finally screwed on, as shown by Fig. 4. Turning the gas on at the meter, but not at the burner, a match is passed round the edges of the boss and over the end of the fitting to make sure that no slight leakage has been started. This is not really likely, but if noticed it may be stopped with a little putty or white-lead. Straight bracket fittings may be converted by the method advised for pendants; or special adapters, obtainable from most gas companies and easily fitted, may be used.

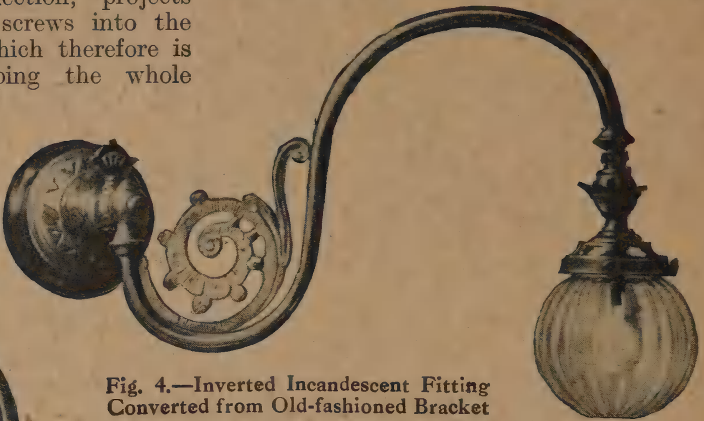


Fig. 4.—Inverted Incandescent Fitting Converted from Old-fashioned Bracket

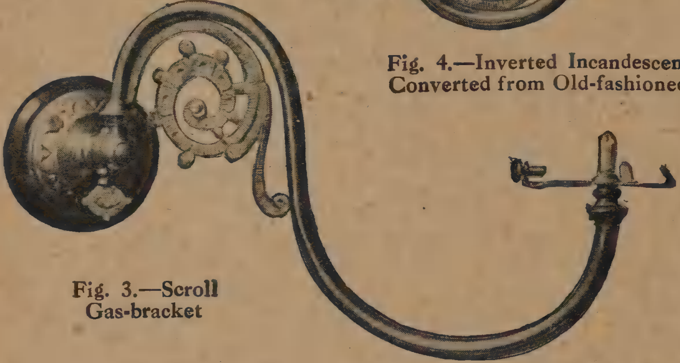


Fig. 3.—Scroll Gas-bracket

Re-stringing a Tennis Racket

It is quite easy to re-string a racket if only reasonable care be taken. First carefully mark on the racket where the catgut begins and finishes. Some rackets are strung with two strings, and when this is so, notice where both of the strings end. Also notice in which way the gut is changed from the vertical to the horizontal strings, and at which hole to begin threading.

Then undo the gut, taking it all from the racket, taking care that the gut is not injured in pulling it through the holes. Rub with a dry cloth to clean and stretch it, and then the gut is ready to be replaced. Now make a large number of wooden pegs, about 1½ in. long and tapering from ¼ in. to the size of the holes in the frame. These are used to hold the string tight while the hole is being threaded; about two-thirds as many as there are holes will be required.

Take the racket and thread the end of the gut through the marked hole, from the inside of the frame, letting it come through far enough to reach round the edge nearly to the handle; turn this end temporarily down through one of the last holes and drive in a peg to hold it tight.

The gut is now tightly fixed at one end to the frame, so thread the other end through the first hole in the top, which will be the ninth from the centre (if there are eighteen vertical strings). Take two turns round the handle of a mallet, and using the handle as a lever, tighten the gut until it gives a rather high musical note when vibrated; pull very carefully and steadily so as not to break it.

Now drive another peg in the hole to hold the gut tight, and after untwisting the gut from off the handle of the mallet, thread the gut down through the next hole and out at the bottom through the next hole but one to the first string and repeat the tightening with the mallet. Then up again, tighten with a peg, continuing until the full number of vertical strings is in, taking care to miss one hole between the last and the last but one string.

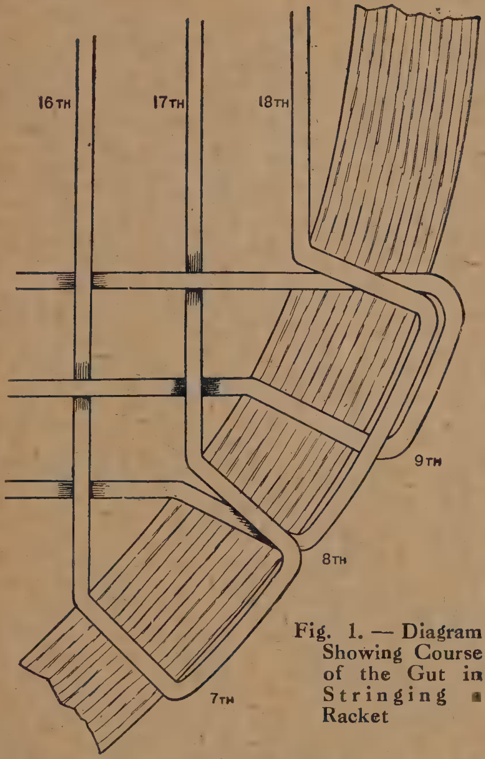


Fig. 1. — Diagram Showing Course of the Gut in Stringing a Racket

This will leave the gut sticking through the tenth hole from the handle on the opposite side to the start; turn it down and thread through the second hole below the same hole as the last but one vertical is in; then in and out through the vertical strings, and finally out through the hole of the second vertical on the other side; tighten with the mallet and drive in a peg. Then turn up through the hole that was missed between Nos. 1 and 2 verticals, weave between the verticals and out of the missed hole, between Nos. 17 and 18, as in Fig. 1, and so on, taking care that the horizontal strings pass alternately above and below the vertical, that they are straightened before being tightened with the mallet, and are pegged at every hole.

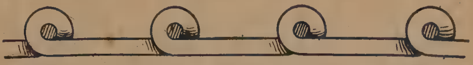


Fig. 2.—Section Showing the Coloured Gut Threaded In

If the string is in two pieces, it can be joined at any hole by making a simple knot on the new length, as in Fig. 3, putting the end of the old length through and pulling down into one of the holes; and then driving in a peg to give greater security. The strings being now all tight and fixed, take the pegs out. The coloured gut should be threaded at the top and bottom to keep the lines at the proper distances apart, twisting as in Fig. 2.

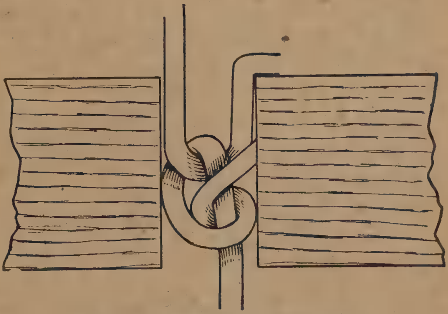


Fig. 3.—Knotting the Gut

When finished, coat the strings and frame with thin spirit varnish.

Fixing Picture Rods and Rails

The hanging of pictures from fixed rails has long been a regular thing in large houses; and now, it is pleasing to note, it is being appreciated as an improvement in all classes of house property.

FIXING PICTURE RODS

The old-fashioned way was mostly to have the rails of brass, or iron painted the same colour as the walls, and this is still preferred by some. The rails are of brass-cased or iron tube, about 1 in. in diameter, and are supported on bracket hooks, the ends being plugged up with wood, and finished with ornaments, as in Fig. 1. The hooks that support the rods are shown by Figs. 2 to 4. Fig. 2 is of iron, for driving into the wall between the bricks, and to be used with iron rails which are painted to match the wall. They are cheap, but rather awkward to drive in. To strike hard on the front of the hook is apt to close it somewhat, so it is necessary to insert something, such as an iron chisel, to convey the force of the blow. The hook is shown as it should fit the rail.

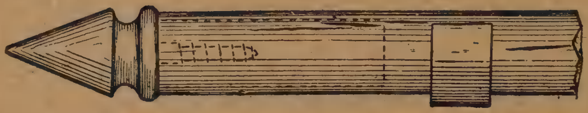


Fig. 1.—Brass Rod on Bracket Hook

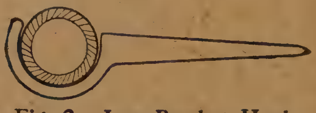


Fig. 2.—Iron Bracket Hook

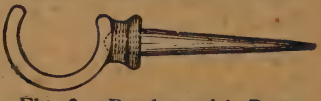


Fig. 3.—Bracket with Brass Screw-off Head

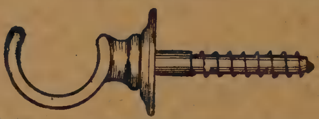


Fig. 4.—Bracket with Screw and Collar-plate

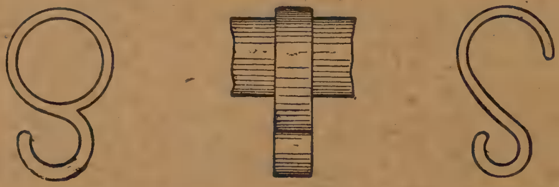


Fig. 5 **Fig. 6** **Fig. 7**

Figs. 5 to 7.—Hanging Hooks for Picture Rod

Fig. 3 shows a brass hook with an iron spike which will screw off for driving in. Fig. 4 is a brass hook having a collar-plate and an iron screw for use in cases where it is necessary to plug the wall and also for lath and plaster walls. The hooks should be placed about 3 in. from the ends of the rail and about 2 ft. apart; but they may be varied according to the number and weight of the pictures. The position of the rails should be just below the cornice mould or below the frieze, when there is one.

It will be understood that in driving in the spikes it is an advantage to get into the horizontal joint of the brickwork, and there will then be no difficulty in getting them in line and at equal distances apart. These joints are 3½ in. apart, centre to centre. Should they not be available, the vertical joints must be used; but they are not so easy to find, and the spikes do not hold so well in them; it may be necessary to drill and plug into the solid brick, and the hooks must then have a collar-plate to cover the plug. It is as well to avoid the labour of plugging if the spikes hold firm without. The way to find the joints is by piercing, with a long bradawl, holes ½ in. apart. The point goes through the plaster about an inch deep, and the brick is easily felt, but when a joint is touched the point goes deeper with a little extra force. A horizontal joint or two must occur in a distance of 3½ in., and a vertical in 9½ in.

For a "lath and plaster" partition the solid wood of the framing must be found for the screws, if the rail has to bear much weight; the screws will hold fairly well in the laths, but the collar-plates must be used.

The hanging hooks (Figs. 5 and 6) are slipped on the rail before it is put on the brackets. When it is desired to add extra hooks without moving the rail, the kind shown by Fig. 7 should be used.

FIXING WOODEN RAILS

The wood moulding picture rails are much more commonly used than the rods, as they serve the purpose quite well, and are cheaper and neater. The mouldings are to be had in various patterns and sizes, the average size being about 2 in. by 1 in. They are usually of bare wood, to be painted to match the other paint-work of the room; but they may also be had finished like picture-frame mouldings, usually white and gilt.

For fixing the mouldings, the walls require to be plugged about 2 ft. or so apart, as the joints between the bricks come convenient. The holes are easily made by chiselling out the mortar; and the plugs should be about 2½ in. by 1½ in. by ½ in., cut to the wedge shape shown by Fig. 8. The vertical joints are the best in this case, and the plugs should be driven flush and to fit tight. The moulding is fixed with two 2-in. oval wire nails

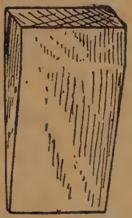


Fig. 8.—Wedge for Use as Wall Plug

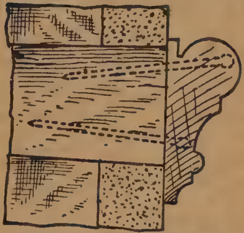


Fig. 9.—Picture Rail Nailed to Plug

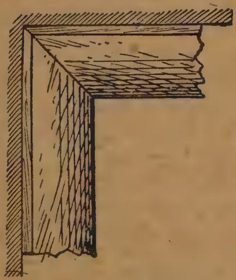


Fig. 10.—Picture Rail Mitred at Angle

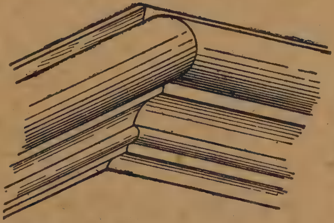


Fig. 11.—Picture Rail Scribed at Angle

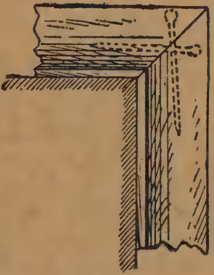


Fig. 12.—Picture Rail Mitred at Corner of Chimney-breast

driven into each plug, the heads being punched down and the holes filled in (see Fig. 9).

In starting the job, the longest wall should be done first, then the next longest, and so on, the shortest piece being put in last. Where the ends meet in the corners they may be cut to a mitre as in Fig. 10, or "scribed." In scribing, the one end is cut square to fit against the wall, and the end to meet it is shaped out with chisels and gouges to fit (see Fig. 11). When it is done well, it has the appearance of a very true mitre, viewed from the front. It is considered better than mitreing; but a workman employs either method, as best suits the occasion.

In working round a projection such as the chimney breast of a room, the front corners must be mitred the reverse way to Fig. 10, and require to be fixed with fine nails, as in Fig. 12. In fixing the moulding to a lath and plaster wall, fine screws, about 2 in., No. 6, must be used instead of the nails.

The plugging could be still more easily done with Rawlplugs, instructions on using which are given on other pages of this series of volumes (see index at end of final volume).

Cleaning Stonework and Brickwork

In the case of stonework that is badly stained with lime from old lime-wash, the chief cleansing agent is muriatic acid, used alone or diluted with water. Try 1 qt. of acid to ½ pt. of water, and add more water if the action is too vigorous. A galvanised bucket must not be employed, but a stoneware basin glazed on the inside will do well. First of all pick out the joints of the masonry and clean off as much of the white lime as possible without marking the stonework, and then brush down the surface of the wall, or the dust will absorb a great deal of the solution. The latter should be put on with an old paint brush about 1½ in. or 2 in. in diameter; and only about 1 yd. super. of wall should be done at a time. After going over the surface, the workman should dip the same brush into a wooden bucket containing perfectly clean water and rinse the wall until all the white lime is off.

In order to remove green moss from masonry, dissolve 1½ lb. chloride of lime in 1 gal. of hot water, then add about a tablespoonful of oil of vitriol (sulphuric acid), and apply to the stonework with a brush. After about five minutes wash off with soda-ash and water.

In cleaning down brickwork, first wash off all dirt with clean water, and then wash the brickwork with diluted spirits of salts in 1 gal. of water, the proportion of spirits depending on the depth of the stains on the walls. A wooden bucket must be used for the solution.

Smoke stains on brickwork are removed with a mixture of 1 gal. of soft soap, 2 lb. of powdered pumice, 00 or F., 1 pt. of liquor ammoniæ, and 3 pts. or more of water. First remove as much of the soot and dust as possible with a stiff broom or fibre brush, and then apply the mixture with an ordinary fibre brush or common whitewash brush. Let it remain for about twenty to thirty minutes, then with a good scrubbing-brush rub it briskly, dipping the brush into clear water once in a while. Have a few pails of clear water handy, and a large carriage sponge to go over the scrubbed surface, and finally rinse with clear water. If convenient, use a hose with spray nozzle for rinsing.

Simple Wood-turning

Having read the chapter on the wood-turner's lathe, simple chucks, and cutting tools, the reader may now desire to attempt some simple turning.

Working the Lathe Treadle.—The beginner may take his first lesson in learning properly to work the lathe treadle. In doing so, always aim to tread it from the knee and hip-joint, lifting the leg easily to the reciprocating action of the treadle so as not to check its motion, and at the same time keeping the body, from the hip-joint upwards, as steady as possible. The working parts of the lathe, such as the pitman, the flywheel, and the treadle-bar bearings, as well as the lathe mandrel, require lubricating. An occasional drop of sweet oil is sufficient for the lower bearings; but the lathe mandrel needs frequent oiling, just a single drop or so at a time.

Chucking the Work. — Where possible, it is desirable, in the first instance, to have the gouges and chisels properly ground and sharpened by an expert, so that the beginner will have the advantage of seeing for himself what properly sharpened wood-turning tools should be like.

It is no use going to needless expense in the matter of "fancy" wood to begin with, because pieces of wood may reasonably be expected to be spoiled in the early practice stages. Odd lengths of pine, provided they are clean and free from knots, are easily and cheaply obtained, and are suitable for practice. But care must be taken that the wood is not dirty; this state spoils the cutting edge of the tools. The pieces of wood may be split or sawn into rods 2 in. or $2\frac{1}{2}$ in. square and 1 ft. 6 in. or so long.

Having gained some practical knowledge of working the treadle, and being provided with the necessary tools and a few pieces of wood for practice, the beginner may proceed to chuck his piece of wood between prong and poppet centres as shown at U, Fig. 1, p. 321 (Vol. II.) The poppet is adjusted to suit the length of the piece of wood, which is then knocked on to the prong-chuck with a light stroke of the hammer, seeing that the prong point is in the centre mark on the end of the wood. The prong should be knocked into the soft pine about $\frac{3}{16}$ in., so as to afford sufficient grip to prevent the prong twisting itself free and boring a hole in the end of the wood, instead of gripping and revolving it. The poppet centre is forced into the centre mark on the other end of the wood by the hand wheel, which, being attached to the screw inside the poppet barrel, causes the poppet centre to slide in or out as the hand wheel is revolved. The poppet centre should enter the end of the wood far enough to prevent the prong working loose; but it should not be jammed so tightly as to cause the lathe to be stiff to drive. To relieve the friction, one spot of oil is dropped on the dead-centre point, and the pinching-screw X (Fig. 1, p. 321 (Vol. II.), tightened up to prevent the dead centre working loose.

Cylindrical Turning.—The T-rest is fixed up so that its top edge is just above the height of the lathe centres, parallel with the work, and about ¼ in. from it, so that the square corners of the revolving wood easily clear the rest. It is also set so as to project a little beyond the work at the dead-centre end to afford a safe rest for the turning gouge.

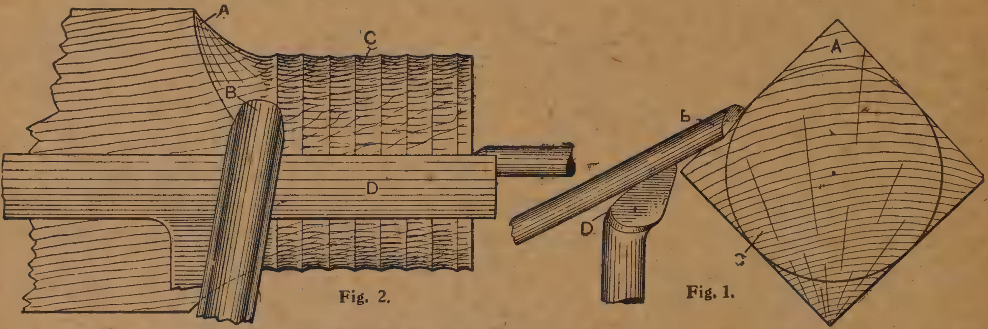


Fig. 2.

Fig. 1.

Figs. 1 and 2.—Cylindrical Turning: The Roughing Down

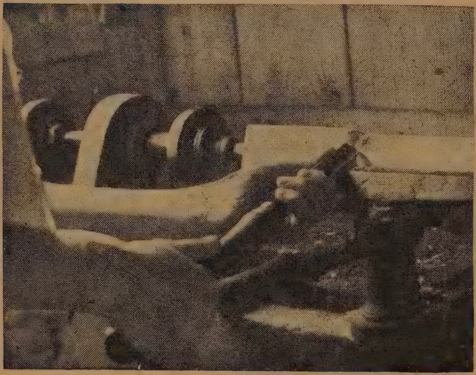


Fig. 3.—Correct Position of Hands and Tool in Roughing Down

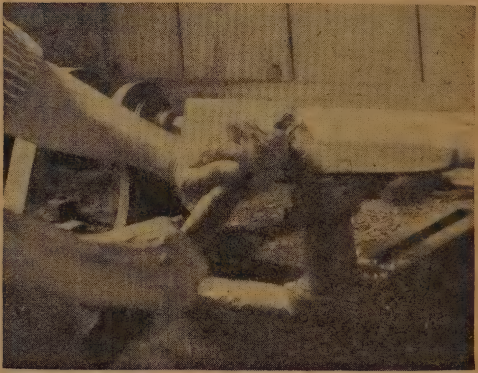
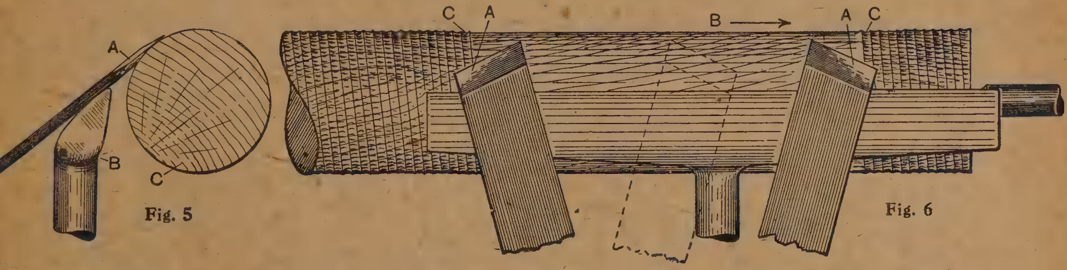


Fig. 4.—Another Method of Using the Gouge in Roughing Down

Start the lathe at a good speed, and grip the gouge handle near the end with the right hand. Place the tool back downwards on the T-rest, gripping the rest from underneath with the forefinger of the left hand, and at the same time supporting the gouge between the thumb, second, third, and fourth fingers. Then proceed to advance the edge of the tool cautiously towards the revolving wood, until by both eyesight and the smooth feel of the cutting it is known that the square corners are turned off. The gouge is then drawn back (not lifted off the rest), and the same operation of cutting in and withdrawing the tool for every cut is continued, until the whole length of the square wood is roughly reduced to cylindrical form.

Fig. 1 herewith shows an end elevation of the work during the foregoing operation; A represents the square corners of the wood which are being turned off by the turning gouge B, and C the turned portion. It also shows the angle at which the gouge is held on the rest D, although, of course, the angle of the cutting edge is altered by the almost involuntary motion of the wrist in slightly raising the tool handle in operating each cut with the gouge. A front elevation is shown in Fig. 2, in which A indicates the square corners in process of turning, while C represents the effects of rough-turning with the gouge. Fig. 2 indicates that the gouge is presented to its work of rough-turning with the edge inclining towards the poppet; when roughing towards the lathe mandrel the edge is similarly inclined slightly towards the mandrel.

It will be seen on reference to Fig. 3 that the gouge is not wrought fairly on its back, but somewhat on its side (right or left side, as the case may be, in rough-gouging to right or left), so that the cutting is done by the point of the gouge and partly by the curved edge next to the lathe rest. The object is to safeguard and prevent the upper curved part of the gouge B (Fig. 2) catching into the wood in roughing off the corners.



Figs. 5 and 6.—Method of Chiselling Round Rod

Fig. 4 shows another method of operating. Instead of gripping the lathe rest from the under-side with the forefinger as in Fig. 3, the tool is controlled and manipulated with the left hand on top of the gouge, pressing it down to the lathe rest. This method is adopted for heavy roughing work. The fleshy part of the hand above the little finger rests flexibly on the T-rest to steady and support the gouge, depressing the cutting edge to the cut in unison with the motion of the right wrist in raising the tool handle, the hand yielding easily and naturally along the lathe rest to repeat the gouging operation.

The next process is to level the roughness C (Fig. 2) and to make the cylindrical rough-turned rod parallel, which is also done with the roughing gouge, preparatory to the final smooth "skinning over" with the turning chisel. In this preparatory levelling the gouge is held much the same as shown in Fig. 1, but instead of being held at an angle, as in Fig. 2, the gouge is held firmly on its back and at right angles to the work, the lumpiness of which is levelled by thus working the gouge to and fro along the lathe rest.

During all these operations the gouge must rest on the lathe rest before allowing the cutting edge of the tool to come into contact with the revolving wood. Otherwise the gouge would be violently jerked down to the lathe rest, which would break the thin point of the tool or jerk the work from between the lathe centres.

"Skinning" the Work.—The next operation is to skin the work smooth and parallel from end to end with the turning chisel. Chisels 1¼ in. or 1½ in. wide are more convenient for this job than are the narrower ones, but the work may be accomplished with a 1-in. chisel. Chisels as narrow as ¾ in. and less are more suitable for skinning-out the concavity of shallow work, the width of chisel being, of course, selected to suit the radius.

As in using the turning gouge, the chisel edge should not touch the revolving wood until the tool rests securely on the lathe rest. With the lathe driving at top speed, the turner grips with the right hand the chisel handle as conveniently near the end as he can, and places the tool flat on the T-rest with the obtuse-angled point towards the poppet centre, and at about 4 in. or 5 in. from the poppet end of the wood. Fig. 5 shows the angle at which the chisel A is held on the rest B to operate the chiselling of the work C. The rest is fixed up slightly above the lathe centres, and by raising the rest higher the angle would apparently be altered, although the chisel would cut just as well by raising up the handle of the tool until the cutting edge is tangential to the work. As a rule, in turning prong- and poppet-chucked work, the larger the diameter of the work the higher the lathe rest is set, to give the worker the better control of the tools. But every turner rapidly fixes up the rest to suit the job in hand, and fixes it to what he thinks is the most convenient height and position to facilitate the manipulation of the tool. Therefore, if the beginner feels that the chiselling operation necessitates an uncomfortable "hitching up" of the right shoulder in raising the tool handle to make the tool cut, he may take it for granted that the lathe rest is set too high, and it should be lowered.

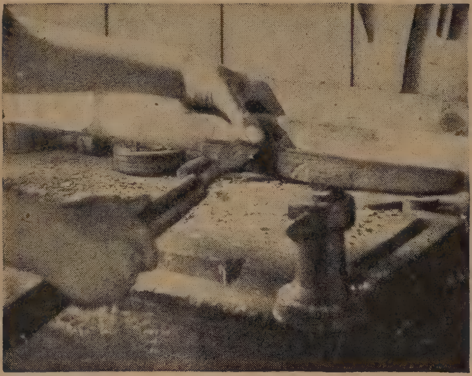


Fig. 7.—Overhand Chiselling to Right

Fig. 6 is a front view showing the chiselling operation in the two positions for smoothing up the rod. The chisel is held as shown, the edge sloping forwards in the direction of chiselling, either to the right or left, as the case may be. The cutting is done with the central part of the edge A, both corners of the tool being quite clear of the work on account of the angle the edge makes with the cylindrical rod. In proceeding to use the chisel, which is laid flat on the lathe rest, the handle is slightly raised, causing the bevelled part of the tool immediately behind the cutting edge to bear on the revolving wood. The cutting edge is then depressed with the left hand to "feel" the cut; the shaving is taken off towards the poppet centre by sliding the chisel along the rest with both hands, guiding and holding the tool at the angle shown in Fig. 6. The dotted lines in this illustration represent the position of the chisel on beginning the cut, the tool being shown by the full outline as having advanced during the chiselling operation as far as C, as can be seen by the smoothing off of the gouge marks. The reverse direction of the chiselling operation is also indicated, starting at B, the chisel being shown slanted in reverse direction for that purpose, and as having advanced during the chiselling as far as C in that direction. The chiselling, of course, may be begun towards either end, the tool being supported by the revolving wood as well as the T-rest.

In the event of the long corner of the chisel accidentally slipping back or down from the proper cutting angle, and thereby catching into the revolving wood, the chisel would be jerked downwards to the T-rest, probably breaking off the tool-point, or at least tearing a splinter out of the revolving wood and knocking the work out of the lathe centres. To prevent such mishaps, it is necessary to use caution; but experience will soon give confidence and skill.

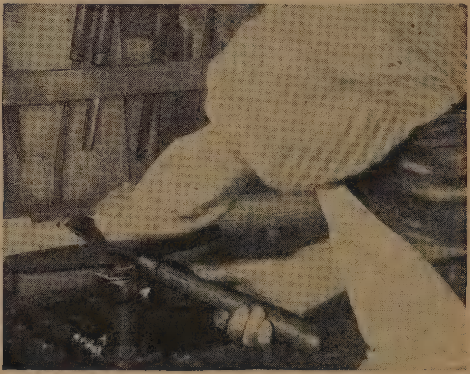


Fig. 8.—Overhand Chiselling to Left

Fig. 7 shows the position of the hands

in holding the chisel whilst operating the chiselling towards the right, in the overhand method. This style of chiselling is most useful for parallel work, for smoothing hard, cross-grained stuff, and it is also the most practical way of chiselling slender, springy work of considerable length. The fingers of the left hand, curving over and partly encircling the work, act as a "stay" in supporting it steadily to the chiselling, while the chisel itself is, in practised hands, easily controllable to the work by pressure and guidance of the thumb.

In the overhand chiselling operation to the left (see Fig. 8) the fingers similarly curve over the revolving work and support it to the chisel. The left hand in this case is crossed over the chisel, the latter being controlled and manipulated along the T-rest principally by the fleshy part of the hand above the little finger. The chiselling operations will require to be practised many times in order to acquire the knack of smoothing the work level and parallel.

Where the grain of the wood runs with the length of the stuff, remember that the cutting with both gouge and chisel must always be with the grain of the wood; that is, the cutting must always be from the periphery to the centre.

Finishing with the Scraper.—Finishing with the scraping chisel is easier, but does not make so clean and smooth a job as the skinning chisel. Nevertheless, it is a useful and even a necessary way of finishing large work, knotty stuff, or such as does not necessitate a glossy, smooth finish. The work having been roughed to cylindrical shape and made fairly smooth with the turning gouge, the scraper is manipulated to and fro along the work to level off any lumpiness, finishing with a light, smooth drawing touch so as to remove a fine continuous shaving and leave the work as smooth as possible. Fig. 9 shows the rest A to be so set that the edge of the scraping tool B, which is held at about right angles to the work C, operates rather above the centre of the work. The scraping chisel is used for finishing flat surfaces also, and for smoothly rounding off beadings on turned work, such as circular bases for stands, etc., which are sawn out from plank wood and turned on the screw-chuck.

Beadings and Hollows.—Beadings and hollows are roughly turned to shape with gouges of various widths, sharpened to rounded cutting edges so that there are no prominent points or corners. It is the point and the lower curved part next the point of the gouge that do the cutting. Thus, in rounding over a ball-shaped bead to the right, the point of the gouge is brought to the cutting position, beginning the cut a little to the right of what would be the greatest diameter of the finished ball. The shaping or rounding proceeds by depressing the tool point with the left thumb or hand, as the case may be, and raising the tool handle with the right hand, and at the same time, by a motion of the wrist, twisting and moving the gouge handle simultaneously to the right. This motion of cutting, though difficult to describe, is really quite simple. The point and lower part of the tool point are presented to the work at an angle which prevents the tool catching in should the upper part of the curved edge get in contact with the revolving work. The shaping of the half of the ball or bead to the left is done in a similar manner, except that the left-hand point of the gouge is brought into use for rounding over to the left.

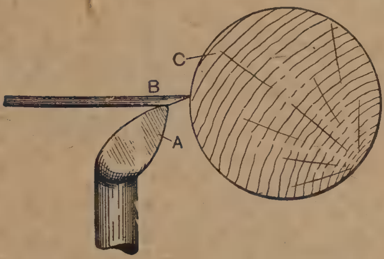


Fig. 9.—Scraping Cylindrical Rod (End Elevation)

When turning the hollows between beadings, the point and under-part of the gouge edge are used as for beadings, but the cutting is done from the outer edges to the centre or deepest part of the hollow. Therefore, in cutting from the right-hand edge of the hollow, the gouge is operated with the left side on the T-rest, and vice versa on the right in cutting the hollow from the left. Several cuts are taken, as depth and width of hollow necessitate, alternately right and left as before, by depressing the tool point; but the wrist motion is exactly the opposite to that for rounding beads, so that in cutting the hollow inwards from right to left, the gouge handle is turned gradually to the right and at the same time moving it towards the poppet end of the lathe. This operation is repeated, the tool and wrist motion being reversed when gouging the hollow from left to right, as represented by the alternate positions of the gouge in Fig. 10, in which A and B indicate the changing position, respectively, at beginning and completing the finishing cut from right to left; C and D denote the reversed positions of the gouge in taking the finishing cut from left to right. In taking the cuts, especially the finishing cut, the gouge should be held firmly at the moment of beginning the cut, with the extreme point of the tool nearly vertical, and, as the cutting proceeds inwards, the back of the tool should bear lightly, in the style of a lever, on the edge of the wood from which the cut is taken; the finishing cuts should meet in the centre or deepest part of the hollow, merging smoothly to an unbroken curve. Figs. 11 and 12 are photographic views of the foregoing operation, showing the correct position of hands and gouge, respectively, in cutting from right to left and vice versa.

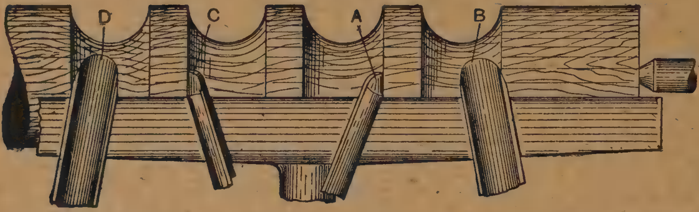


Fig. 10.—Method of Gouging Hollows

The same piece of wood (Fig. 10) will also afford additional practice for the gouge, inasmuch as the beginner may next try rounding over the "flats" between the hollows, as shown in Fig. 13, in which the arrow-heads indicate the direction of the gouge-cuts.

Figs. 11 and 12.—Position of Hands and Gouge in Cutting from Right to Left, and vice versa

Finishing Beadings with the Chisel.—Although in many cases beadings which merge into concave curves are advantageously finished with the turning gouge, groups of beadings, ball-shaped mouldings (such as in table legs, chair legs, etc.) for general cabinet work, are usually finished with the turning chisel. In the example shown by Fig. 14, the piece of wood is chucked between the prong and the poppet centre, roughed to cylindrical shape, and smoothed with the chisel from end to end. The spacing of the beadings can then be set out by revolving the lathe and marking the division lines from a foot-rule with a lead pencil, with the marking point on the revolving cylinder; or the lines may be marked by setting the compasses to the width of the beads and working the points, scraper fashion, on the lathe rest to score the wood. The spaces between the beadings are next cut in to depth with the parting tool, the cuts being taken to the insides of the spaces so as to shear the lines to the width and depth of the beads.

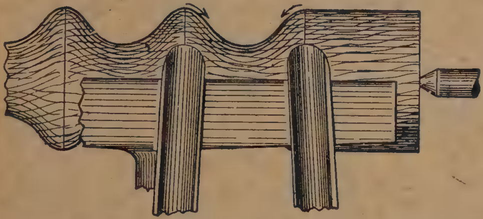


Fig. 13.—Detail for Gouge Practice in Forming Beadings, etc.

The parting tool is largely used for separating sections of finished work, as well as for the purpose of spacing and cutting beadings to the required depth. The method of using the tool is clearly shown in Fig. 15, in which A represents the parting tool (supported on the rest B) operating into the work C. The tool is squarely held on either of its narrow edges on the rest, and at right angles to the work, as at A (Fig. 14), the kerf-like cut B being taken out by gradually thrusting the point of the tool into the revolving wood, and at the same time raising the tool handle according to the depth of cutting. If, in deep cutting, the tool has a tendency to jam, the kerf is eased by withdrawing the tool and slightly widening the kerf by taking off a cut from the waste side of the stuff. The waste stuff C between the beadings is next roughed out with the turning gouge, and the spaces then smoothed to right and left with the turning chisel as indicated at D, and the beads also roughly shaped with the turning gouge.

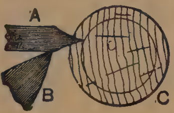


Fig. 15.—Parting Tool in Use

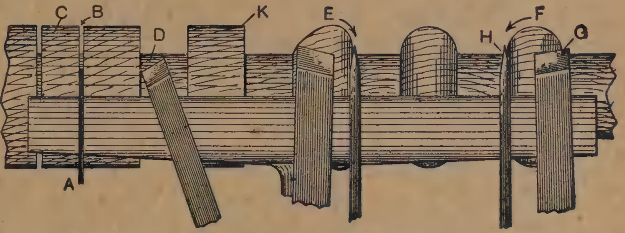


Fig. 14.—Detail for Chisel Practice in Forming Beadings, etc.

The arrow-heads E and F (Fig. 14) indicate the direction of the cuts in finishing the beads to right and left with the turning chisel. The cutting is done with the short corner of the chisel. It can, however, be done with the long corner, and also with the chisel held as for cylindrical smoothing; but for a beginner the practice is not recommended. The cut is begun by placing the flat side of the chisel on the rest as at G, cutting from the largest diameter and operating the cutting corner of the tool in the direction of the arrow to the left by gradually twisting the tool handle, and at the same time raising it

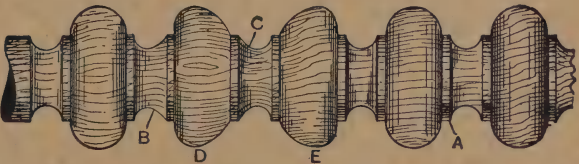


Fig. 16.—Finishing Turned Beadings

to depress the tool-point and adapt the cutting to the decreasing diameter. The handle is moved round so that the motion gradually alters the position of the tool to the vertical, that is, with the narrow edge on the rest at finishing the cut as shown at H. The plain portion K shows how the bead should appear before rounding over with the gouge and chisel.

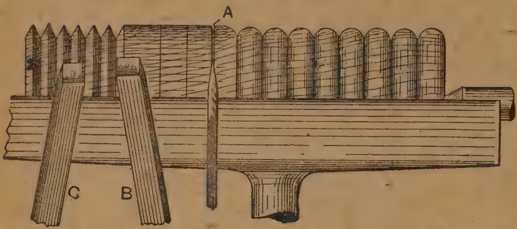


Fig. 17.—Beadings to be Finished with Turning Chisel

Fig. 16 shows the further development of the pattern Fig. 14. The semicircular hollows between the beadings have been turned out; this is the practical application of the gouging lesson detailed in Fig. 10. A $\frac{3}{8}$-in. gouge is the proper tool for this job, and in using it see that the corners of the lists A are not left round, but cut sharp, with the hollows symmetrical and cleanly cut. In Fig. 16 the hollows B and C are shown alternately diverging to right and left from the semicircular, as are also the beadings D and E, to accustom the beginner in using the tools equally in turning the varying beads and hollows which usually occur in turned work.

Glasspapering the Beadings.—Having satisfactorily turned the job, it should next be finished off smooth with glasspaper. The sheet of glasspaper (No. $1\frac{1}{2}$) should be folded with the smooth side inwards, and cut up into suitable size squares, each of which is folded flat into two for smoothing beadings, or with the folded edge roll-shaped for glasspapering in the hollows. Particular care should be taken, especially with coarse glasspaper, not to destroy the sharp edges of the lists with careless rubbing; the glasspaper is firmly pressed on the revolving wood, and at the same time kept moving somewhat slowly to and fro, to prevent scratch marks.

Another Beading Pattern. — For working out the pattern of beadings shown in Fig. 17, which is finished entirely with the turning chisel, a piece of 2-in. square stuff is chucked between the prong and poppet centres, roughed down with the gouge, and smoothed parallel with the turning chisel. The round beading to the right, and also the angular beading towards the left, are then set out by means of a marking stick or compasses. The first operation in chiselling the round beading is to cut in the dividing lines between each bead to the depth of the rounding. To do this, the chisel A is held vertically on the rest at right angles to the work, and the dividing lines cut to the required depth with the long corner of the tool, the job being done by raising up the tool handle and at the same time advancing the point by sliding in the tool slightly forward to the work, so that the tool-point cuts in wedge fashion, as indicated at A. The beads are then rounded over right and left with either the long or short corner of the chisel.

The angular beading to the left is line-marked and cut in from right and left to the centre with the long corner of the turning chisel, and in this case the tool is not held with its narrow side flat on the lathe rest, but on the outer angle of the narrow edge of the chisel, so as to accommodate the angle of the cutting edge to the inclination of the bead, as indicated at B and C. The cuts are then made by depressing the point of the tool with the thumb concurrently with the raising of the tool handle, so that in taking each cut the tool-point describes an arc instead of sliding on the rest.

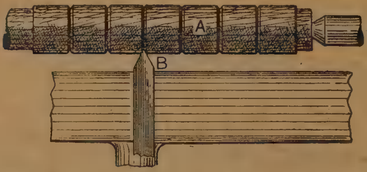


Fig. 18.—Cutting Brass Tube into Ferrules

Turning Tool Handles.—New wood-turning tools as procured from toolsellers are usually supplied unground and without handles. The wood for making the handles may be birch, beech, ash, etc., obtained sawn up in 1½-in. square rods, which can then be cross-cut into lengths to meet requirements. The stuff for gouge and chisel handles may be cross-cut 10½ in. or 11 in. long, which allows for cutting off the waste piece at the prong-chuck ends. The pieces of wood are centred on the ends for prong- and poppet-chucking, and each piece may have the hole for the tang of the tool bored before the handle is turned. To bore the hole, the square rod is held vertically in the vice, and the poppet centre mark indented with a centre-punch to afford an accurate starting point. The hole is then bored 3½ in. or so deep with a ¼-in. nose-bit, held in an ordinary brace.

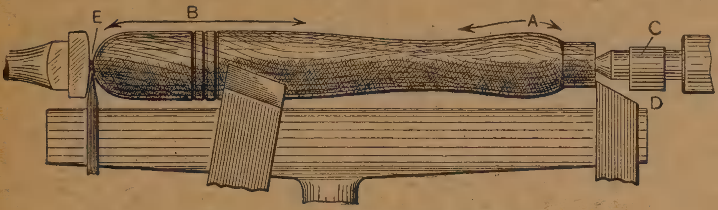


Fig. 19.—Turning a Tool Handle

To prevent the handles splitting they are fitted with ferrules made from brass tubing, which can be obtained from any ironmonger. The brass tube can be sawn into lengths of about ¾ in. with a hack saw, but, unless the ends are turned true, they are apt, through uneven sawing, to make a clumsy fit on the handles. A length of brass tube long enough for half a dozen ferrules can be chucked on a turned wooden pin held between the lathe centres, and cut with a metal-turner's diamond-point tool as in Fig. 18, A indicating the tube and B the diamond-point tool; this tool must not be confused with the wood-turner's diamond-point tool. The tool for turning the ferrules is made from an old triangular file ground up to a diamond-point shape, and will rapidly cut through the brass tubing.

When turning the handles, if the size of ferrule permits, it is handy to slip the ferrule on the poppet centre, as at C (Fig. 19), to facilitate the turning of the ferrule tenons to size. And to save the trouble of turning both ends of the ferrules—the ends being, of course, left bevel-edged by the diamond-point tool—the shoulder against which the ferrule abuts may be undercut with the turning chisel, as shown at A (Fig. 20), which represents an enlarged section of the rough-turned handle, showing the ferrule tenon and the hole B for the tang of the tool. The ferrules are tightly driven on, not with a hammer, but by resting the ferrule on a piece of hard wood and driving the handle into it.

Fig. 19 indicates the manner in which the handle is re-chucked between the prong and poppet, and the end of the ferrule turned square down. This can be done with the metal-turner's diamond-point tool, or with the edge of an old flat file which has the teeth ground off for 1½ in. or so, and the edge also ground to an obtuse cutting angle, as shown at D. The handle is then reduced to shape with the turning gouge, the arrow heads A and B indicating the direction of the finishing cuts with the turning chisel. After smoothing with glasspaper, the handle can be rubbed with woollen rag moistened with linseed oil, and then burnished with a handful of the fine chisel shavings. Finally, the waste piece which carries the prong mark is cut off with the corner of the chisel, as indicated at E, the chisel cuts being alternately taken from right and

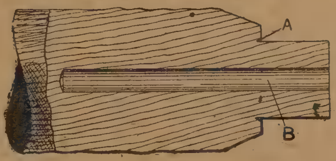


Fig. 20.—Undercut Shoulder to Receive Ferrule

left until the neck is reduced to about $\frac{3}{16}$ in., so that there is no danger of tearing a piece out of the end of the handle with a thrust of the chisel when cutting the neck through.

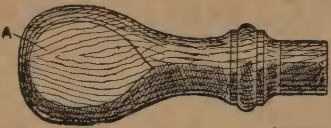


Fig. 21.—Screwdriver Handle

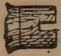


Fig. 22. — Slotted Ferrule and Tenon

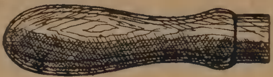


Fig. 23.—File Handle

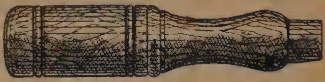


Fig. 24.—Chisel and Gouge Handle

Screwdriver and Other Handles.—Screwdriver handles (see Fig. 21) are turned with a bulb-shaped head to afford leverage in twisting the screwdriver. The ferrule and tenon are slotted (see Fig. 22) to suit the thickness of the blade, in order to prevent the tang of the latter twisting loose in the handle. The screwdriver handle may be turned, and the flat cheeks afterwards sawn off and dressed as shown at A (Fig. 21) with the smoothing plane. Figs. 23 and 24 show handles for files and joiners' chisels and gouges, the turning of which will be understood from the instructions given above.

Fixing Tool Handles.—In fixing the turning tools in their respective handles, the holes may require some enlargement, especially for the tangs of the larger size gouges and chisels; but this can easily be done by reamering them slightly with an ordinary shell reamer held in a hand brace. In fixing the tools see that they are straight in line with the handles, both front and edgewise. The tang (not the fluted blade of the gouge) is held firmly and vertically in the vice, and the handle driven on the tang fairly tight with moderate strokes of the hammer.

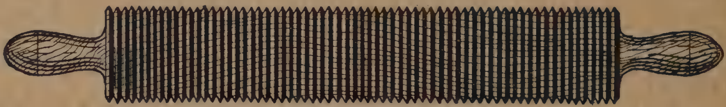


Fig. 25.—Oatcake Rolling-pin

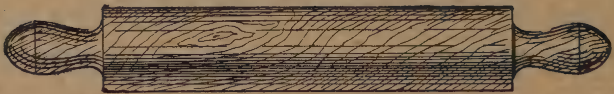


Fig. 26.—Plain Rolling-pin

Turning Rolling-pins, etc.—General wood-turning includes such articles of domestic use as rolling-pins and potato mashers shown by Figs. 25 to 28, and the best wood for this class of goods is plane-tree. Sound branch wood of suitable size, and free from knots, is much used for this purpose. Branches that will turn about $2\frac{1}{2}$ in. to 3 in. in diameter are most profitable to use.

The oatcake rolling-pins are turned about 3 in. or so in diameter and 1 ft. 9 in. long, inclusive of the handles, which are 3 in. long, and finished as shown in Fig. 25. The plain rolling-pin (Fig. 26) is turned 1 ft. 7 in. long over all, and from $2\frac{1}{2}$ in. to $2\frac{3}{4}$ in. in diameter; these rolling-pins, when made of boxwood or lignum-vitæ, may be of the same length, but only $1\frac{1}{2}$ in. in diameter, and finished without handles. The potato mashers are turned 1 ft. 5 in. long and in proportion, as shown in Fig. 27. In each case 1 in. or so longer than finished length should be allowed for cutting off waste ends at the prong and poppet centres.

The turning of the potato mashers and plain rolling-pins should not present much difficulty. The former, being rough-turned to shape with the gouge, are finally skinned over with the turning chisel and finished with glasspaper. In finishing the rolling-pins parallel, the plane-iron scraping tool makes a smooth job, and will also be found much quicker than the ordinary turning chisel, which need only be used for finishing the handles.

The honeycomb rolling-pin (Fig. 28) is used for impressing a pattern on pastry, and, being a better-class job, these pins should be made from quartered stuff, to turn up finished size $2\frac{1}{4}$ in. in diameter and 1 ft. $3\frac{1}{2}$ in. long. These pins are first beaded in the lathe, similarly to the oatcake rolling-pin, and afterwards the beading is made longitudinally.

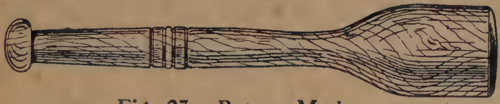


Fig. 27.—Potato Masher

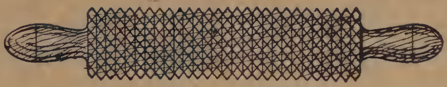


Fig. 28.—Honeycomb Rolling-pin

Making a Beading Plane.—The beading of the oatcake and honeycomb rolling-pins could be done with the turning chisel, as shown in Fig. 17 (p. 146); but it would take a considerable amount of time and trouble to do the entire length of beading in that way. With the beading plane, illustrated by Figs. 29 to 32, the beading of the rolling-pin is regularly, quickly, and easily done. Any handy woodworker should be able to make the beading plane from the accompanying drawings and instructions. It is best to use two planes, one with $\frac{3}{16}$-in. pitched bead for the oatcake rolling-pins and one with $\frac{1}{4}$-in. beads for the honeycomb rolling-pins.

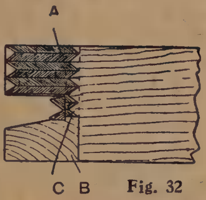


Fig. 32

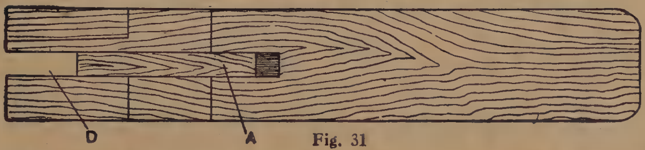


Fig. 31

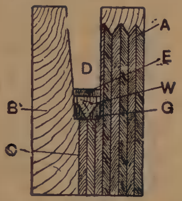


Fig. 29

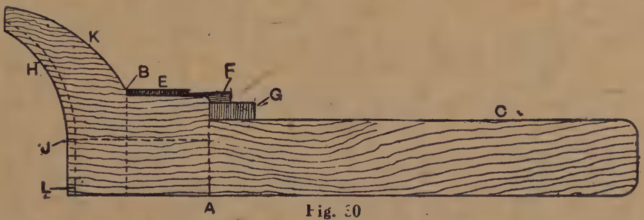


Fig. 30

Figs. 29 to 32.—Front Elevation, Side Elevation, Plan and Underneath Plan of Lathe Beading Plane

The most durable wood for making these planes is lignum-vitæ or Persian boxwood, failing which fairly good wearing planes can be made from sound beech. The block of wood for making the beading plane should be cut about 11 in. long over all, and 3 in. deep by $1\frac{3}{4}$ in. wide; and although elaborate finishing is unnecessary, except for appearance, it is best to dress the piece of wood squarely to the above dimensions to ensure accuracy in setting out. At 3 in. and $4\frac{1}{4}$ in. from the front end of the block pencil lines are squared across both sides, as indicated by the dotted lines A and B (Fig. 30). Then gauge lines $1\frac{1}{4}$ in. and $1\frac{5}{8}$ in. are marked from B and A denoting the thickness of the longitudinal handle C, and the shoulder D, which, after the gab for the cutter is cut out, is fitted with a metal plate E of either iron or brass, to form the bridge for the wedge F that fixes the cutter G. The working face of the plane is drawn with compasses, the curve H being drawn to a radius of 2 in. from a centre pivot (not shown) on the dotted line J, which is gauge-marked $\frac{7}{8}$ in. from the under-side of the block. The upper curve K is then marked and the block sawn out to the outline shown in Fig. 30. Before sawing out the complete outline, it is best to finish the guide beads, and also to smooth off the unbeaded part of the working face of the plane. First the curve H only should be cut out and dressed smooth and square across the face, the lower part from the dotted line J to L being finished straight, as it does not require to be curved below the cutter; the guide beads are carved with a V-shaped carving tool. The guide beads are next lined out for carving with the marking gauge, the lines being gauged $\frac{3}{32}$ in. apart for top and root of bead, as indicated in Fig. 29. The block is then fixed in the bench vice whilst carving the beads, the tool cuts being taken from the straight part towards the curve, and along the lines A (Figs. 29 and 32). The beads are $\frac{1}{8}$ in. deep and $\frac{3}{16}$ in. wide, giving an angle of about 50°. Having made a fairly smooth job of the guide beads, the left-hand side of the tool face (which is unbeaded because it would be a waste of time to bead beyond the centre bead which is in alignment with the cutter) is cut smoothly away to the level of the guide-bead root, as shown at B (Fig. 32). For guidance in doing so, the line B is squared across as shown, and a line $\frac{1}{8}$ in. from the curved edge (the depth of the bead) is gauged round the opposite side, as shown dotted at L (Fig. 30), and the wood trimmed off to the centre guide bead C (Figs. 29 and 32).

The block is next sawn to the outline of the plane (Fig. 30), and the gab for the cutter cut out, as at D (Figs. 29 and 31). The gab being sawn down with the tenon saw to the level of C (Fig. 30), the waste wood is chipped out with a mallet and chisel, and the gab finished, as shown, straight at the guide bead side, bevelled at the other side (Fig. 29), and also, as shown in the plan view, bevelled at the rear for the free delivery of shavings. The cutter bed is sunk slightly at A (Fig. 31), the bed being straight, although sunk at the rear, and it is also made slightly wider than the cutter to facilitate the adjusting of the latter in alignment with the guide bead underneath, as shown in Fig. 29, in which G represents the cutter, E the metal bridge, and W the wedge.

The bridge is shown in Fig. 33, it being drilled and countersunk for fixing on with 1-in. screws as at E (Fig. 30). The wedge (Fig. 34) may be either of wood or metal. In the latter case it can be made from a piece of old triangular file. The file is heated to redness, and allowed to cool slowly; it will then be found soft enough to file or grind to shape. The wooden wedge should be of boxwood.

The cutter can be made from a piece of square tool steel filed out to the shape shown in Figs. 35 and 36, and it is ground and sharpened like the curved parting tool. For finally smoothing and polishing the groove of these cutters, the writer turns up little hard-wood polishing bobs, as shown by Fig. 37, about 2 in. in diameter, two or three similar bobs being turned, 2 in. or so apart, on the same piece of wood. The polishing is done by dressing the bobs either with glue or sweet oil and a dusting of fine emery. The V-groove of the cutter is moved to and fro on the bob with the lathe driven at a good speed.

The lathe beading plane for honeycomb rolling-pins is made similar to the one already described, with the difference that it cuts $\frac{1}{4}$-in. beads; the guide beads are cut $\frac{1}{4}$ in., and proportionately deeper, at the same angle. The curve of the working face should be cut out to $1\frac{3}{8}$-in. radius, and both planes should have the sharp edges of the handle rounded off to form a comfortable grip for the hands.

In setting the cutter for beading, it is adjusted so that the point A (Fig. 36) projects slightly beyond the top of the guide beads, and also in alignment with the bead underneath. The wedge, being slightly tapered, is lightly tapped (mostly with the narrow edge of the turning chisel) into position, from the rear, sufficiently tight to hold the cutter from slipping back.

It may be thought that a flat diamond-point cutter will do for the beading plane instead of the V-shaped cutter. Flat tools of the diamond-point order work well enough on the end grain of the wood, but such cutters will not turn the beadings on cylindrical work. The grain of the wood running lengthwise, it is unable to stand the action of flat cutters, which simply tear up the stuff, stripping the beads and spoiling the work. In mechanically turning beads or groups of beading, the cutters should not be made like flat moulding machine cutters, as sometimes erroneously represented; but they should have the outline of the desired beadings formed on the cutter, as in the V-cutter for the beading plane.

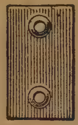


Fig. 33.—Metal Plate for Beading Plane

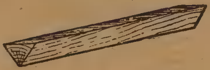
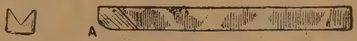


Fig. 34.—Wedge for Beading Plane



Figs. 35 and 36.—Cutter for Beading Plane

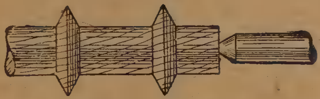


Fig. 37.—Wooden Polishing Bobs

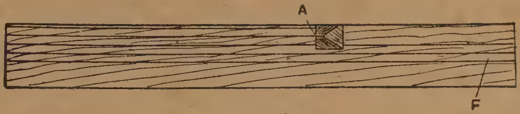


Fig. 40

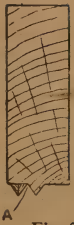


Fig. 38

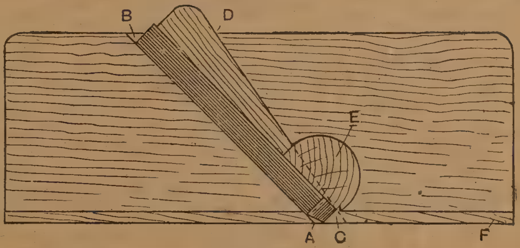


Fig. 39

Figs. 38 to 40.—End Elevation, Side Elevation, and Plan of Plane for Beading Rolling-pins Longitudinally

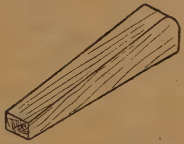


Fig. 41.—Wedge for the Second Plane

Plane for Beading Rolling-pins Longitudinally.—The plane for beading the honeycomb rolling-pins longitudinally is a home-made tool (see Figs. 38 to 40); and the best wood for making it is boxwood, although one made of good hard beech will work well and last a long time. The piece of wood required for this plane is 8 in. long, 3 in. wide, and 1 in. thick. This thickness is for a boxwood plane, but if made of beech it should be 1⅛ in. thick, on account of the cutter gab and wedgeway being cut open from the side, as indicated in Fig. 39. Thinner stuff might become warped with the tightening of the cutter wedge.

Preparatory to marking the guide bead lines and setting out the gab, the piece of wood for the plane is dressed up squarely. Then the lines for the guide beads are gauged from the gab side, the gauge lines being marked as before for apex and base of beads, but in this case ⅛ in. apart. The beads are then cut out with the parting tool; any roughness can be levelled off with a triangular file or a piece of glasspaper folded over a wedge-shape piece of wood. The work at this stage is shown at A (Fig. 38). The cutter bed is next set out at 3 in. distance from the front end and at an angle of 45°, as at A B (Fig. 39); the line C D is at an angle of 55°. The gab is then cut in straight to these lines with the tenon saw, and the waste wood between the saw kerfs chiselled out level to such depth as will bed the cutter in alignment with the gauge bead, as indicated at A (Fig. 40). The portion

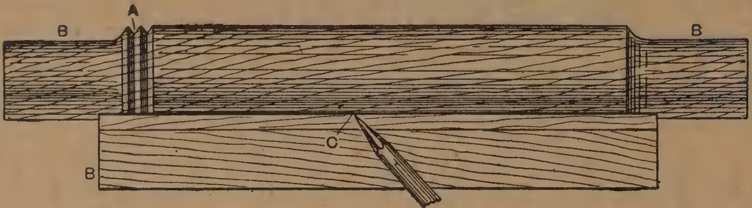


Fig. 42.—Drawing Guide Line for Honeycomb Rolling-pin

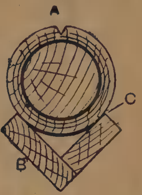


Fig. 46.—End Elevation of Honeycomb Rolling-pin

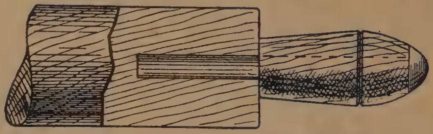


Fig. 50.—Part Section through Rolling-pin Showing Revolving Handle

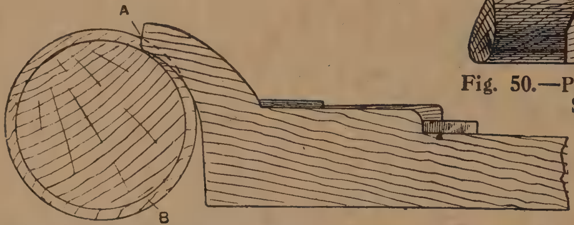


Fig. 43.—End Elevation Showing Beading Plane in Use

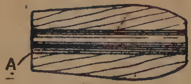


Fig. 48.—Section of Revolving Handle for Rolling-pin

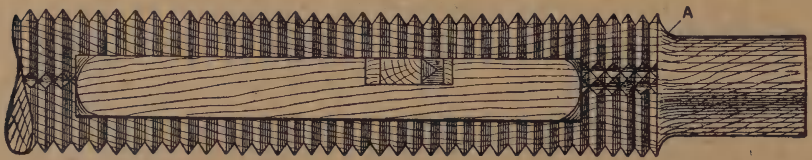


Fig. 47.—Cutting Honeycomb on Roller

Fig. 45.—Photographic View Showing Beading Operation

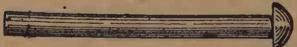


Fig. 49.—Turned Pin for Revolving Handle

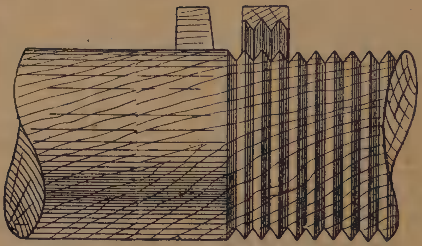


Fig. 44.—Back Elevation Showing Beading Plane in Use

of the guide bead in front of the cutter is then stripped off, and the gab clearance for free escape of shavings gouged out, as indicated at E (Fig. 39). The wedge (Fig. 41) for fixing the cutter is made of box or beech. The cutter for the lathe beading plane previously described should be interchangeable for this plane. A beech plane works and wears much better if liberally dosed with linseed oil.

Turning Beaded Rolling-pins.—The rolling-pins are usually turned up in quantities, being first rough-turned with the gouge, and, for the purpose of being easier wrought, usually from unseasoned stuff. The work in this state is then allowed to stand a short time to season, the length of time depending on the sappiness of the wood. Thorough seasoning is not necessary for this class of goods, and a slight mellowness in the wood facilitates the beading. The rolling-pins are re-chucked between the prong and poppet centres for beading and finishing; they are turned parallel to eyesight, and a starting bead to guide the beading plane is turned, as shown at A (Fig. 42); B B indicate the rough-turned handles. Fig. 43 shows an end elevation and first position of the beading plane engaging the starting bead of the rolling-pin with the top or upper part of the tool A in contact with B to feel the work before the cutter is advanced. The cutting of the bead is accomplished by the same motion of sliding the plane forwards and upwards, which brings the cutter into operation until it cuts itself clear, as shown in Fig. 44. A repetition of this motion with the guide bead tracking the next newly-cut bead, continued bead after bead, completes this part of the work, after which the handles are turned to shape.

Turning Honeycomb Rolling-pins.—The honeycomb rolling-pins are beaded in a similar manner, but the handles are not finished until after the longitudinal beading is done. Fig. 45 is a photographic view of the beading plane in use.

A starting bead to guide the longitudinal beading plane (Fig. 39) is run with the parting tool along the honeycomb rolling-pins, as shown at A (Fig. 46). A pencil line is first drawn as a guide for the parting tool; but when numbers are done at a time, it is quicker to make the arrangement shown at B. It is simply two straight pieces of wood nailed squarely together about 2 in. wide and ½ in. or so thick, and of sufficient length. The line is made by drawing the pencil along the edge C, as indicated in Fig. 42.

In using the longitudinal beading plane, the guide bead F (Figs. 39 and 40) leads along the starting bead A (Fig. 46), as in Fig. 47, in which A is the bead in process of cutting, sufficient pressure being applied to ensure cutting out full beads at each stroke of the plane. Although this may appear to be a heavy cut for such a tool, it is easily done on account of the relief from previous lathe beading.

Rolling-pins with Revolving Handles.—Rolling-pins with revolving handles have the handles turned separately, with a hole centrally bored through the handle, as shown at A (Fig. 48). Pins (Fig. 49) are turned to suit the hole through the handles, and corresponding holes, a tight fit for the pin, bored in the ends of the rolling-pins. The pin, handle, and rolling-pin are fitted together in the manner shown in Fig. 50.

CUP-CHUCK TURNING

The instructions already given in this chapter are mostly for prong and poppet work. The prong would not hold securely work that requires to be hollowed out, and it becomes necessary to employ either the taper screw-chuck or the cup-chuck. The former is principally used for work of large diameter in which the grain of the wood runs transversely to the axis of the lathe mandrel; sometimes work of small diameter and inconsiderable length, with the grain of the wood running lengthwise, is also turned on the screw-chuck, but for such a purpose the cup-chuck is better.

Chucking the Work.—This, in the case of the screw-chuck, is simply done by centre-popping the work, boring a suitable hole in the centre-pop mark, and then screwing the work tightly on the screw-chuck until the work abuts fairly to the face of the chuck, the only precaution being to be careful not to "overhaul the screw." In the case of cup-chuck work, either of the two methods shown in Figs. 51 and 52 may be adopted. In the first method the square rods are cross-cut into lengths of 7½ in. or so, and the square corners chipped off one end to a roughly round section, as indicated at A (Fig. 51), the size to suit the chuck. Only so much of the corners is taken off as will permit the extreme end of the rod being knocked into the chuck with a smart stroke of the hammer. The best hammer for turners is about 2 lb. in weight, fitted with a short, stiffish handle about 9 in. or 10 in. long, so that a good, hard stroke can be delivered.

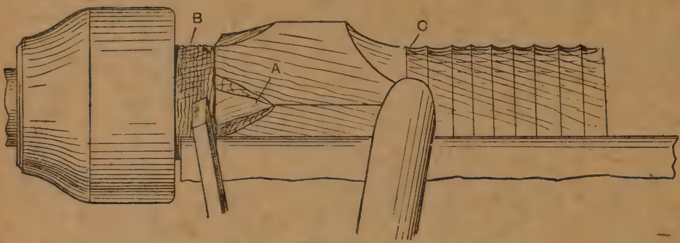


Fig. 51.—Cup-chucking of Square Rod

The rod is held with the left hand as centrally as possible towards the chuck whilst driving it into the chuck with a smart stroke of the hammer. Then revolve the lathe slowly with the left hand to note the approximate truth of the rod, which is easily seen by noting the eccentricity of the corners of the rod in relation to the T-rest. A very few strokes of the hammer, driving the rod into the chuck, should bring it approximately true. Then, the lathe being set in motion, the chipped corners are quickly "ragged" or roughed to the round with the long corner of the turning chisel as at B (Fig. 51), so as to enable the workman to drive the rod firmly and truly into the chuck. Then the turning proceeds as shown, the corners being rough-turned off with the turning gouge as indicated at C, and the work afterwards finished, as the case may be, with the gouge or turning chisel.

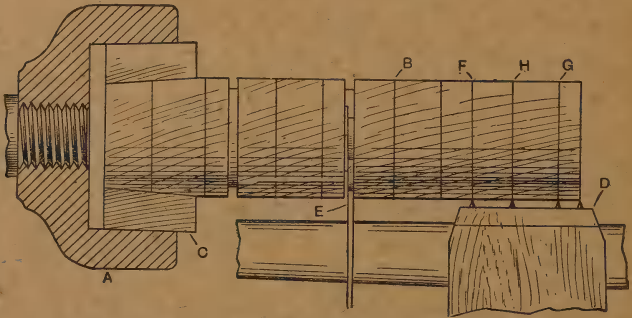


Fig. 52.—Cup-chucking of Rough-turned Rod

An alternative way of preparing the work for chucking in the cup-chuck (the stuff being similarly cross-cut into lengths) is shown in Fig. 53. In this case the square rods are first chucked between the prong and poppet, and rough-turned to nearly the round, leaving the diameter a trifle larger towards the poppet-centre end of the rod as at A, and tapering slightly from A to B for driving into the chuck. The diameter at A may be easily gauged with the eye; but the diameter at B must be such that the ends just enter the chuck to drive tight with the hammer; and the way to ensure this is by adjusting the callipers to the internal diameter of the chuck, callipering the rod end A whilst in the lathe, as shown in Fig. 54, which also shows how the callipers are used for all external calliperings.

The chucking of such rough-turned rods is shown in Fig. 52, the chucking being shown in section, which is also meant to explain how the professional wood-turner adapts larger chucks to suit for chucking and turning up work of much smaller diameter than the internal diameter of the chuck. As shown, A represents the cast-iron chuck, into which is tightly driven a hardwood stopper with the central hole turned through it to suit the rod B, the stopper being left long enough to project as shown at C, to facilitate its removal, which is done by knocking it out with a block of wood used drift fashion on the projecting part C, so as not to destroy the stopper. These wooden stoppers are very useful, and save a multiplicity of smaller cast-iron chucks. They are made to serve the purpose of the smaller chucks by simply turning the internal holes to a diameter that suits the work on hand. Also, they are used, and make very good substitutes, for metal chucks, for holding centre-bits, nose-bits, etc., for boring in the lathe. They are, of course, preserved for future use, and if carefully used last a long time.

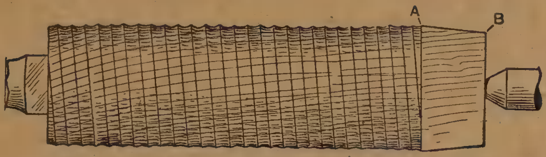


Fig. 53.—Preparing Rod for Cup-chucking

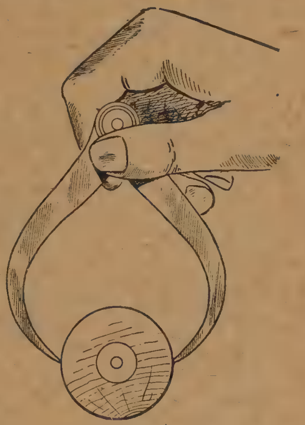
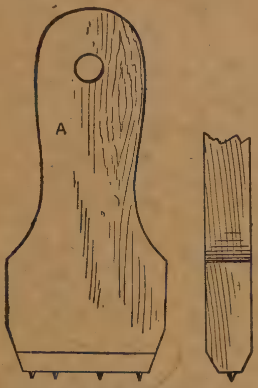


Fig. 54.—Using the Callipers



Figs. 56 and 57.—The Marking Stick

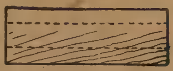


Fig. 60.—Stop-gauge for Boring-bit

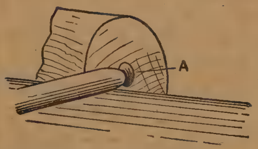


Fig. 58.—Gouging Centre for Boring-bit

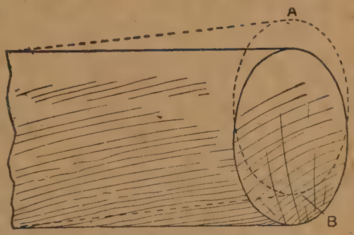


Fig. 55.—Centering Cup-chucked Work

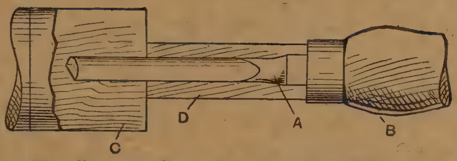


Fig. 59.—Boring with Handled Nose-bit

The rods must not be struck sidewise in centering, because this loosens the grip and may possibly cause the rod to fly out of the chuck later on. Fig. 55 will perhaps help to explain how to centre the work quickly and truly. The dotted line A suggests the amount by which the rod may be out of centre. The lathe is revolved backwards with the left hand, until the highest part A is brought diametrically opposite the workman and held in that position whilst delivering a "drawing" stroke with the hammer on the nearest part towards the workman, as indicated by the dotted line B. Should either a wooden or metal chuck become "glazed" with use, and thus fail to grip, a rub with a piece of chalk or whiting will at once remedy matters.

Turning Drawer Knobs.—Assuming the rod (as rough-turned in Fig. 53) to be firmly chucked and truly centred in the cup-chuck, the beginner may essay the turning of some such simple work as drawer knobs. Strip the rod smooth and parallel with the turning chisel, and then mark off into knob lengths as shown at D (Fig. 52). The marking stick is made from a piece of hardwood about $\frac{3}{4}$ in. thick, with a wire nail driven into the end and filed up to a fine marking point, and finished as shown by Figs. 56 and 57, the part A being rounded to form a grip for the hands. The end of the rod is squared down with the long corner of the turning chisel or with the $\frac{3}{8}$-in. gouge on its side as in Fig. 58; still keeping the gouge on its side, the operation is completed by swinging the tool handle towards the right, and (cutting from the centre) at the same time forcing the gouge point to hollow out the central depression A to form a start for the boring-bit. The hole is next bored, tapping size for $\frac{1}{2}$-in. wood-screwing tap, with a nose-bit fixed into a tool handle as shown in Fig. 59, in which A and B represent the boring-bit and handle boring the hole in the knob, as indicated in part section at C, the hole being bored about $1\frac{1}{4}$ in. deep.

To prevent boring too deeply, the nose-bit may be file-nicked $1\frac{1}{4}$ in. from the point, and the nick kept in sight during the boring. But partly because it illustrates a simple boring stop-gauge, which can also be used on boring-bits revolving in the lathe, the bit is shown as provided with the stop-gauge D, these stop-gauges being prepared from any odd pieces of hardwood bored with the bit they are to be used with, and turned as shown in Fig. 60 into required lengths.

After the hole is bored and chamfered with the gouge (see A, Fig. 58), the knob lengths are cut off with the parting tool (see E, Fig. 52), the actual line being, of course, at F. The lengths are next tapped as described in the chapter explaining how screw threads are cut in wood.

Finishing Drawer Knobs.—To make the chuck for finishing the knobs, a spare piece of hardwood is driven firmly into the cup-chuck and left projecting about 2 in., and the end turned down to form the pin for the screw A (Fig. 61). In cutting these short screws the screw-box is held squarely and firmly to its work with the right hand, whilst the left hand manipulates the chuck by twisting the work towards the worker until the screw-box abuts fairly against the shoulder B. The left-hand operation is reversed to release the thread, and, of course, there is no need to move the T-rest for this job, the screw-box being held the long way upright. The lathe is then set in motion, and the point of the thread cut off (as in Fig. 61) with a firm, steady cut of the turning chisel, three threads being amply sufficient for wood screw-chucks of this sort.

Fig. 62 illustrates the first operation in finishing the knob, showing the parting tool A "deepening in" to the list on the lines G and H (Fig. 52); the waste wood C (Fig. 62) is roughed away. The knob is turned as shown in Fig. 63, the arrows indicating the direction of the finishing gouge cuts, the job being finally smoothed with glasspaper. Fig. 64 shows a rather more elaborate drawer knob, similarly screwed on the screw-chuck A, for which a different marking can be made to suit.

Screw for Drawer Knob to Fix On.—The male screw that goes through the drawer front for the purpose of fixing on the knob is shown by Fig. 65. These screws can be chucked between the prong and poppet, and turned as shown in Fig. 66; or they may be chucked in the cup-chuck and turned as in Fig. 67. In the second case, the thread can be made on each before cutting it off, similar to the short threads in making the chuck, with the difference that (as shown at A, Fig. 65) these screws passing through the thickness of the drawer do not require the threads cut up to the shoulder. Therefore the threads are cut with the covered

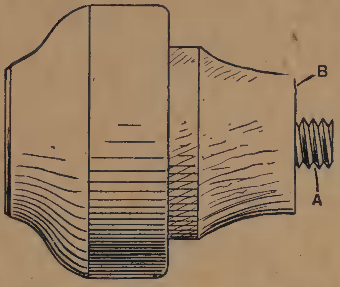


Fig. 61.—Wooden Screw-chuck

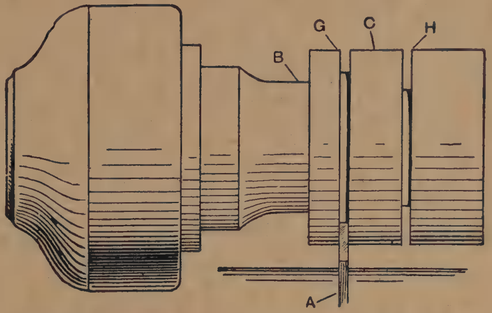


Fig. 62.—Using Parting Tool for Deepening-in

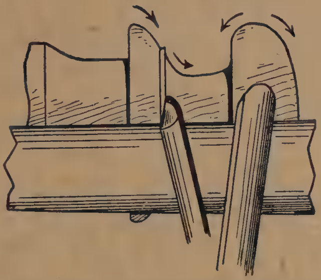


Fig. 63.—Turning the Drawer Knob

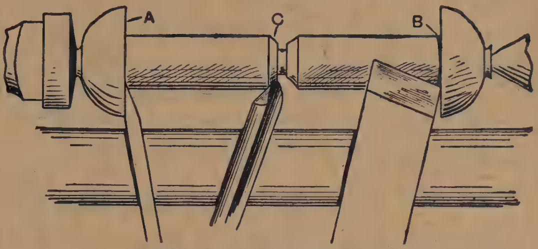


Fig. 66.—Turning Blank for Drawer-knob Screw, between Prong and Poppet

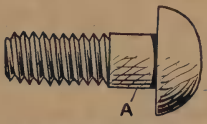


Fig. 65.—Screw for Drawer Knob

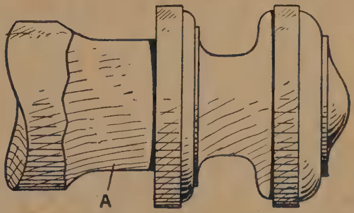


Fig. 64.—Another Pattern of Drawer Knob

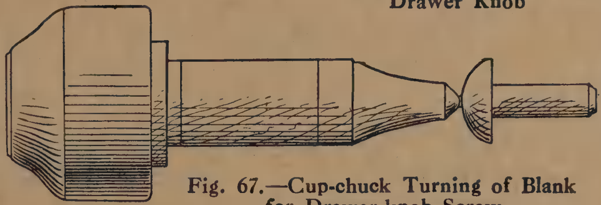
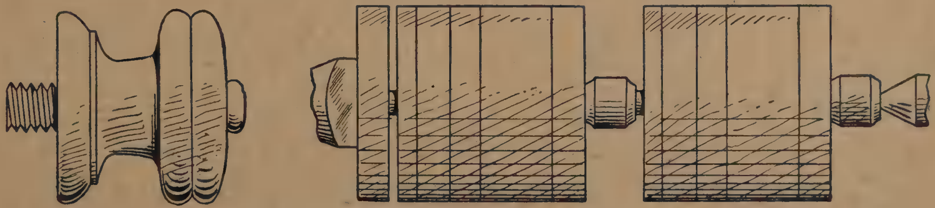


Fig. 67.—Cup-chuck Turning of Blank for Drawer-knob Screw



Figs. 68 and 69.—Knob with Solid Screw, and the First Operation in Turning it screw-box, which, to the beginner, is best on account of its easy guidance. The shoulders of the pins are cut square, or even slightly hollow, with the long corner of the chisel as at A (Fig. 66), sinking the chisel well in beyond the diameter of the pin, so that the shaving cuts clean away when chiselling into the shoulder B. The chamfering for starting the thread is done with the gouge as at C, the gouge cut being, of course, in reverse position in cutting the chamfer on the other one.

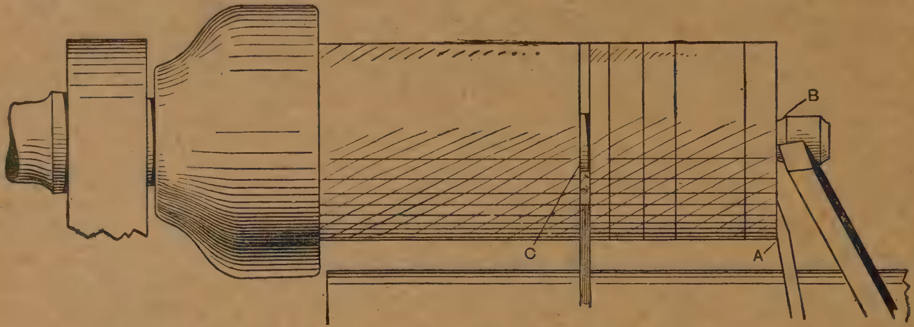


Fig 70.—Cup-chuck Turning of Solid-screw Knob

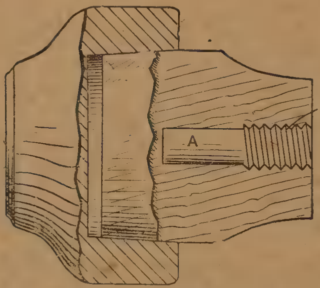


Fig. 71.—Section of Screw-chuck

Solid-Screw Knobs.—In the style of knob shown by Fig. 68 the screw forms part of the knob. Such knobs can be roughed out between the prong and poppet with the pins ready for screwing, after cutting asunder as shown in Fig. 69; they could also be finished in this way before screwing. The rough-turned stuff is cup-chucked as before, the lengths marked off with the marking stick, and the pins for the screws roughed down with the gouge, shouldered down with the chisel as at A (Fig. 70), and then cham-

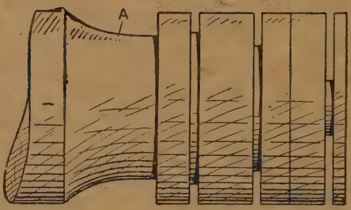
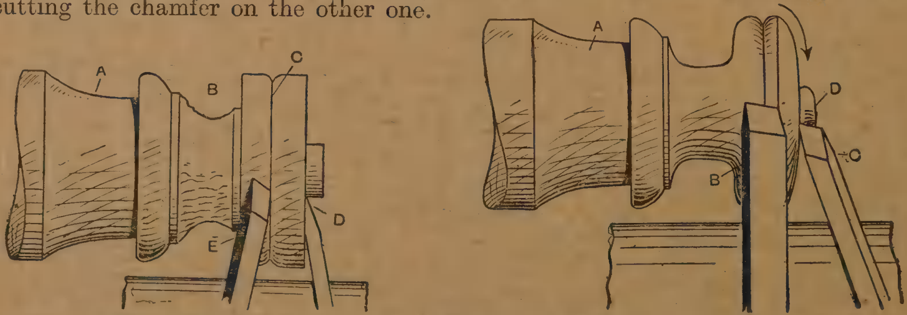


Fig. 72.—Cutting-in the Knob with Parting Tool



Figs. 73 and 74.—Finishing the Turning of the Solid-screw Knob fered to the shoulders as at B. The screws are then cut as already described for the male screw-chuck, and the knob lengths cut off with the parting tool as at C.

A section of the wooden screw-chuck for turning the solid-screw knobs or similar screwed work is shown by Fig. 71. A piece of hardwood is chucked in the cup-chuck, same as for the other screw-chuck, and bored as shown at A to suit the tap, and the thread tapped as at B.

Figs. 72 to 74 illustrate the process of finishing the knob. The knob, being screwed into the chuck A, is first "cut in" with the parting tool as in Fig. 72, and after roughing away the waste wood between the parting-tool kerfs with the gouge (to shape something like B, Fig. 73), the long corner of the chisel is thrust straight in on the dividing line C, as shown also at D, to form the parting between the beads, which are then rounded over with the chisel as at E, right and left to the parting line.

The finishing cuts are as at B and C (Fig. 74), the outside rounding of the end boss D being best finished with the $\frac{3}{8}$-in. gouge.

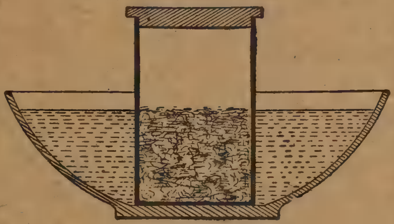
Making Celluloid Varnish

CELLULOID varnish differs in many respects from other varnishes. It is perfectly transparent and colourless, and dries with the formation of a very thin film. It is neutral in its reaction, and hence it is especially suitable for use in conjunction with bronze colours, which with ordinary oil varnishes are apt to turn green owing to the acid which they contain.

Nitro-cellulose.—The first operation in the preparation of celluloid varnish is the production of the nitro-cellulose, which is a substance closely related to gun-cotton, and therefore requires a certain amount of care in its manufacture. Nitro-cellulose is prepared by the action of a mixture of nitric and sulphuric acids on cellulose. The forms of cellulose usually employed are pure white paper and cotton. Cotton-wool may be used, but the best form of cotton, perhaps, is a pure, fine cotton yarn—that is, a cotton yarn which has not been sized.

The mixed acid is made by first adding 100 parts of the strongest sulphuric acid to 10 parts of water. As some heat is generated when the two are brought together, the vessel in which the mixing is performed should stand in a basin of cold water to keep down the temperature.

When the liquid has become quite cold, 50 parts of the strongest nitric acid should be added, and a cover placed over the vessel to keep in the fumes which are evolved. The mixing of acids is best done in an earthenware jar provided with a lid; the capacity of the jar may conveniently be about 2 lb., but the mixture of acids should not occupy more than half the space of the jar, as indicated in the illustration. When the mixed acid has become quite cold, the cotton, in a loose state, may be placed in the jar and pressed down with a glass rod until it is thoroughly moistened, and the lid of the jar then replaced. Heat is generated during the reaction between the cotton and the nitric acid, hence the jar must be kept in the basin of cold water as before.


Jar in Cold-water Bath

At the end of twenty minutes, the cotton should be raised with a glass rod and pressed to remove as much as possible of the adhering acid, then immediately removed and plunged into a large basin filled with cold water. Cold water should be allowed to flow into the basin from a tap for about an hour to remove the excess of acid; and, to make sure that the material is quite neutral, a little ammonia should be added to the water in the basin, the cotton stirred well in it, and then the washing continued as before for another hour, after which the cotton may be removed, squeezed, spread loosely on a clean sheet of white paper, and then dried very slowly at the ordinary room temperature. The mixed acid remaining in the jar will be somewhat weak, but can be used with fresh acid for making further quantities.

Not more than 2 oz. or 3 oz. of cotton should be treated at one time, as larger quantities are not easily manipulated. It is essential that the cotton should be thoroughly saturated with the acid, or the reaction will not be complete. The nitro-cellulose will be found to differ in its properties from ordinary cotton; it is much harsher to the touch, and is not so strong, the fibres being much more readily broken.

The Solvent.—The preparation of a varnish from the nitro-cellulose formed as above described presents no difficulty. There is a choice of solvents. The material is readily soluble in a mixture of alcohol and ether in acetone, and in amyl acetate. A mixture of alcohol and ether is very volatile, and a varnish made with it dries very rapidly. The varnish is known as collodion and is used in photography, in pharmacy, and in the manufacture of incandescent mantles.

For ordinary work, a mixture of 2 parts of methylated spirit and 1 part of methylated ether may be employed. The nitrated cotton should be placed in a dry, wide-mouthed, stoppered bottle, covered with the mixture of alcohol and ether, and stirred from time to time. In a short time the cotton becomes transparent, swells up, and forms a stiff jelly, whereupon more of the solvent should be added, and this repeated until a moderately thick fluid is obtained. If the cotton has been fully nitrated, the solution will be quite clear and transparent, but if anything should remain undissolved, the liquid should be very quickly pressed through a fine cotton cloth, and collected in a second dry bottle. The proportions of nitro-cellulose and solvent required are about 1 part of the former to 50 parts of the latter, so that in the finished varnish there is only about 2 per cent. of nitro-cellulose, hence the reason why it yields such a thin film on drying. Ordinary varnishes contain at least 40 per cent. of oil and resin; they therefore leave a much thicker film when they dry.

Commercial acetone is used as a solvent in the same way as the mixture of alcohol and ether.

When amyl acetate is employed, the nitro-cellulose should be just covered with it, and as soon as the latter has softened and assumed a jelly-like consistency, the mixture may be diluted with petroleum spirit, which is much cheaper and evaporates more readily than the amyl acetate.

Both the nitro-cellulose and the solvents mentioned are very inflammable, and very great care must be exercised in the manipulation of the materials.

The addition of 1 or 2 per cent. of castor oil to these liquids will convert them into flexible varnishes.

Simple Process for Home Requirements.—This chapter has described the best methods of producing celluloid varnish; but as the processes are lengthy and the amateur would scarcely care to go to so much trouble if he needed only a small quantity, it is as well to say that a varnish can be made from commercial celluloid itself. The best method is to shred finely 1 oz. of celluloid and to dissolve it in a small quantity of acetone or amyl acetate, afterwards making up to 20 oz. by adding more of the solvent. Other proportions are: 1 oz. of celluloid, 5 oz. of acetone, and 20 oz. of amyl acetate; dissolve first in the acetone, and then add the amyl acetate. Celluloid varnishes can be coloured with aniline dyes, and they are the very best medium for mixing with various bronze powders for making "gold," "silver," or "aluminium" paints; 20 oz. of the varnish will require from 1 oz. to 4 oz. of the bronze powders—the proportions not being of much importance, and being best determined by simple experiment.

Cleaning and Restoring Oil Paintings

PICTURES that are neglected generally become in time obscured by a dirty film. On the face the dirt has become fixed to and almost incorporated with the varnish. But this varnish will have saved the picture from harm, for if both the dirt and the varnish can be removed, the colours will reappear in their primitive freshness as bright as the first day that they were laid on. The following process will present no great difficulty in re-lining and cleaning pictures that have become obscured chiefly by smoke and dirt. A beginning should be made with a picture of but small value.

REMOVING VARNISH

It is first necessary to discover whether the picture has been varnished with copal or mastic varnish, coated with oil, or whether with water varnish such as albumen, size, or isinglass, all of which are to be found on various paintings. The method of cleaning adopted will be determined accordingly. So different are the kinds of oils, varnishes, and preparations found on a picture, that the solvent which one would bear in safety would ruin the other. Old and hard mastic varnish can generally be reduced to a powder by rubbing with the dry finger. When there is a great breadth of varnish to be rubbed up, as in a background, a bottle cork can be used instead of the fingers; but nothing but the fingers should be used on the more delicate parts. Whether the painting is on canvas or panel, scrubbing the varnish so as to bring into prominence the threads, or grain of the wood, should be rigorously avoided. This is generally accomplished by means of the tips of the fingers, acting on the top of the uneven surface, rubbing it bare before cleaning the sunken parts sufficiently. If the varnish is recent it is easily removed, but in proportion to its age it becomes difficult. In the latter case it is often useful, before attempting its removal, to give the work a new coat of varnish, and on rubbing or applying a solvent it will be found to have attached itself to the old, and both may be removed without difficulty.

Removing Copal Varnish.—For the removal of copal, or when the picture is on rough-surfaced canvas which has very many interstices, a solvent may be required. A mixture of spirit of wine and oil of turpentine is employed, allowing the turpentine to predominate if the picture is delicate and the coat of varnish thin. Every time before use the bottle should be well shaken, then a little poured on the picture, and gently rubbed, using a piece of soft flannel or cotton-wool, with a circular motion. As soon as the varnish has dissolved in any part it should be wiped off quickly with another rag. Thus the varnish and dirt are removed from all parts, and the solvent allowed to remain on only the exact time for doing this, it being preferable to leave a little dirt on the painting, rather than to render it weak and cold by too much cleaning. The rag which gathers up the soiled varnish as it comes off the painting should, when saturated, be thrown away and a fresh piece substituted, which, being clean, serves also to clean the work. A little oil of any kind will, if occasionally applied, act as a new varnish, and the progress of the work will clearly be seen.

If this mixture fails to remove all the dirt, more powerful solvents might be applied, such as potash, soda, or carbonate of ammonia. They should be weakened by the addition of water and sparingly used, and a sponge and clean water frequently applied in order to see the progress made. Before much water is used, however, the state of the painting must be considered, for if the colours are much broken up or cracked, the solvent may penetrate to the ground and quickly rot it, and even the cloth itself in the case of old paintings. Sulphuric ether has also been recommended as a strong solvent. This is used with spirit, and its action, as soon as it has answered the intended purpose, may be checked with olive oil, or water in which a small quantity of soap has been dissolved.

It is difficult to tell, except by experience, the various varnishes on a picture, but copal may generally be known by its resistance to the ordinary solvents. For removing this, a fine-edged knife is sometimes employed, and the stronger solvents, such as potash and liquor ammoniæ fortis, are used.

Removing Mastic Varnish.—For soft varnishes, such as mastic, spirit of wine of 56° strength should be diluted with a sixth part of linseed oil, or a fourth part of water, or a fourth part of rectified spirit of turpentine, or all in combination. Turpentine hardens the paint, making it safer to work on, while the oil prevents bloom, and the progress of the work can be seen better. To apply the solvent, which must be well shaken whenever used, take a piece of wadding in each hand, saturate the piece in the right hand with the solvent, and the one in the left hand with rectified spirit of turpentine. Begin with the solvent, rubbing a very small portion (say two or three square inches) of the surface in a circular direction. After two or three rubs the solvent rubber will be discoloured by the varnish it has taken up; turn to a clean part and rub again, immediately wiping the place so cleaned all over with the turpentine rubber. The turpentine acts as a deterrent, instantly stopping the action of the spirit and hardening the paint. Judgment must be used to determine when the varnish has been completely removed. The cotton rubber must be frequently renewed—the more often the better—as the varnish taken up by the rubber stops the action of the spirit. Watch the rubbers for the appearance of colour, and at the slightest indication put the left-hand rubber into action. Continue the process until the whole of the picture is cleaned, and then wipe over with turpentine. When this has evaporated, the surface is ready for re-varnishing.

Removing Old Oil.—Very often a painting has received a coating of oil, and in time has, with dust exhalations, smoke, or gas, formed on its surface a crust which obscures the painting itself, and dimmed its freshness and corrupted the effect of the proper colours by a yellow hue. To restore the colours to their original freshness it will often be sufficient to cover the picture repeatedly with linseed oil, frequently renewed over several days, in order to soften the underlying crust, removing afterwards both oils with spirit of wine. Another way is to reduce it somewhat to the nature of soap by the alkalis already mentioned, and clearing away the soap with pure water.

With unvarnished pictures that are soiled by smoke and dirt, it is hardly advisable to apply solvents to clean them. The remedy generally is to remove as much dirt as possible with a piece of soft leather, damped and wrung nearly dry, assisted by the use of either powdered pumicestone or whitening, or both together. If this is unsuccessful, alkalis may be employed. It should be remembered that the work requires extreme care in order to preserve the glazings and last finishing touches of the artist, which, if removed, ruins the picture.

To clean pictures coated with size, isinglass, or albumen, use pure water, warmed if necessary.

LINING A PICTURE

In most cases, if a picture has not already been lined, it is best that this should be done before the operation of cleaning. A painting constitutes in itself a solid crust which may be removed, if necessary, from the canvas or panel with which it is not actually incorporated, and placed on a new foundation. More frequently, however, the old canvas is strengthened by a new one, which is done in the following manner.

The face of the painting should be first pasted over with sheets of paper or fine muslin, which preserves it from scratches or injury during the subsequent processes, especially if the painting is cracked or has holes in it. Then, when the paste and paper are dry, the canvas is taken off the old mount to which it was nailed, and cramped on a perfectly flat and level board or table. All the roughnesses and patches are next effaced with pumicestone. It will then be ready to receive its new cloth, which is previously covered with copal varnish or glue ; or paste can be well brushed on the back of the picture. The lining is well pressed down on the picture by pressing the hand over in every direction. When nearly dry a warm (not too hot) iron of considerable weight should be passed over the new canvas until it is perfectly flat, taking care to do this on a smooth surface, as any mark underneath will be impressed in the painting and cannot be obliterated.

The picture may now be fixed to a new stretching frame, and when the adhesive has hardened, the paper which protected the front may be removed with a sponge and cold water.

TRANSFERRING PICTURE TO NEW CANVAS

When the canvas on which the picture is painted is so decayed or broken as to render it desirable that the picture should be taken off and transferred to a new one, its front should be covered with paper as before, and the edge of the picture glued or tacked face downwards to a smooth board or table.

Having been thus prepared, the old cloth is then removed, either by means of acid or with a rasp or file. A raised border of wax should be made all round the edges, and a weak solution of nitric acid poured on. The mixture should remain on just long enough for the threads to be quite destroyed, which can be ascertained by the touch. The acid is then dabbed off, and beginning at one corner, using a bone or ivory paper-knife, or any instrument not of metal, the rotted canvas threads can be gradually separated from the subjacent crust.

When the old canvas is entirely removed the picture back should be well washed to remove all traces of acid and wiped with a soft sponge. When dry, a fine muslin coated with copal varnish should be applied, afterwards the new canvas, and a warm iron passed over it ; finally it is tacked to a new stretcher. Then the paper which protected the front is removed.

Instead of employing acid, a great deal of the old cloth may be removed with a small rasp or file, finishing with fine pumicestone, and stopping on the first appearance of the ground on which the picture was painted. The old canvas may also sometimes be removed, almost whole, by damping with water to dissolve the preparation which fixes it to the under-surface, and leaving it for a time. Then, beginning at a corner and drawing it diagonally, it can be gradually removed from the paint.

The proper tool for stretching canvas has two broad nippers with teeth for gripping the cloth, and a fulcrum which allows of a very powerful leverage. It is not advisable to stretch old canvas tightly on account of its liability to split. It is, however, in a condition after the process described to allow of its being stretched. Bagging of the cloth may be remedied by a little paste applied to the back, which, as it dries, will contract the canvas.

Old paintings which have been much exposed to damp and bad air, or have been otherwise much neglected, often have cracks and fissures, and the ground peeled off in places, and before beginning to rectify the colour it is necessary to repair such damages.

When the varnish and dirt have been removed, the cracks and damaged places should be filled up with white-lead, or putty made with pipeclay and paste or size. It should be applied stiff and pressed well into the damaged places with a palette knife, and where the broken parts are of any extent, care must be taken to obtain an even surface by smoothing down when dry with pumicestone. The work should next be wiped with a soft cloth dipped in turpentine to remove any greasy matter, and then given a thin coat of varnish in order to view the colours in their proper hue. When dry it may be painted with oil colours, making all the tints a little lighter than the tones they are matched with, as all colours ground in oil dry a little darker than the original hues shown on the palette. After restoration, the work should be left to allow plenty of time to permit the changes to take place which new paint invariably undergoes, so that the places may be corrected whenever necessary. The oil will rise to the surface, and may be removed with a piece of rag or crumb of bread, leaving the body of the colour in the purest possible state.

Electrotyping

THE electro-deposition of copper is treated upon earlier in this work, and it is not proposed to repeat here any account of the processes or appliances there explained. In electrotyping it is possible to make such an object as a coin or a medal serve as its own mould. To do this, it is necessary to clean the side of the medal thoroughly and on the other side to soft solder a wire. Then take some of the stopping-off varnish mentioned on p. 207 of Volume I, and cover the side that is not required to be copied, taking care not to get any on the other side. After allowing to stand till dry, gently brush some pure blacklead on the cleaned face of the medal, to prevent the deposited copper from adhering to the medal. The coppering solution consists of 10 oz. of sulphate of copper dissolved in 1 qt. of boiling water. Before immersing in this, breathe upon the face of the medal to be copied; at once immerse with that side towards the copper anode, and use a gentle current. If the deposit has been put on properly, a coating thick enough to stand removing will be upon the medal in about twenty-four hours. Take out of the solution, dry, gently heat near a bunsen burner, and the electrotype can then be easily detached. The deposited copper will be rather hard and brittle, and to give it a certain amount of ductility place it on a piece of sheet-iron and lay this upon a clear fire till the copper becomes red-hot. Then lay aside to cool, and after this dip for a second or two in a mixture of nitric acid 1 part, sulphuric acid 2 parts, and water 2 parts; rinse immediately afterwards in clean water and dry in sawdust.

This electrotype must now be treated as the copy, and the same routine must be followed as before, including the "stopping off" on the back. A copy in relief will be the result, and this can be made of any thickness desired by leaving it in the coppering solution long enough. It can then be fixed and mounted, or used in any way required, being an exact facsimile of the original.

The usual way, however, of obtaining an electrotype is by use of a mould or moulds. For this purpose, gutta-percha is one of the best materials. Take a sufficient quantity of this and immerse it in hot (not boiling) water till it is quite soft. Then roll it into a ball between the palms of the hands; place again in hot water for a minute or two, then put it upon the centre of the medal and press it slowly, from the middle outwards, to a uniform thickness. The object to be achieved in pressing is to expel all air and to get a good impression. When this has been accomplished, leave the gutta-percha to set for about half an hour, or longer, according to the weather.

When the gutta-percha has set hard it may be removed and blackleaded. The blackleading is done only on the face to be copied, and the blacklead should be applied carefully and thoroughly in the form of a fine powder by means of a soft camel-hair brush. Any of the blacklead which may adhere to the edges or other part of the mould must be removed by rubbing with a clean rag slightly damped. Do not handle the gutta-percha any more than is absolutely necessary. The next thing to do is to embed one end of the conducting wire in the gutta-percha. This can be done on any part of the mould which suits it best, but there must be a blacklead connection prepared by the camel-hair brush between the prepared face of the mould and the wire. This need be nothing more than a line of the blacklead about $\frac{1}{8}$ in. broad. The jointing is done by heating slightly one end of the wire in a bunsen burner and embedding it in the gutta-percha, taking care not to injure the face of the mould. The depositing process is the same as before described. Steady and regular working will take about two days to attain the necessary thickness. When finished, take up the mould and its wire, and cut off the latter carefully close to the mould. Then immerse mould and "type" together in some hot water for a few minutes, when it will be found that the gutta-percha will readily separate from the electrotype. If it is desired to "back" the electrotype, soft solder may be used.

Plaster moulds can be used instead of gutta-percha. For these, take a bowl of water, and drop gradually into it with the fingers sufficient fine plaster-of-paris. Pour off all the superfluous water as soon as the plaster has settled. Then place the medal, after coating its surface well all over with linseed or olive oil, upon a sheet of glass with a wire laid to it, and place around it a strip of cardboard so as to enclose the medal, leaving a good margin between. Stir up well the plaster-of-paris to a uniform consistency, then carefully and slowly pour it over the medal level with the top of the cardboard, and leave it for about an hour to set. The cardboard may now be removed and, the plaster being still soft, but not liquid, may be trimmed with a knife to any desired shape, and removed from the glass. Remove the medal and then brush all over the mould some melted paraffin wax and put it in an oven to dry and to allow the wax to soak in. If only one side of the medal is required, blacklead over the face of the impression carefully and attach to a wire, making the necessary conducting joint and placing in the coppering bath. If both sides of the medal are required, it will be necessary to take a mould of the other side. To do this, coat again the flat side of the existing mould, where it was attached to the glass only, with more paraffin wax, and put it into the oven. When the wax is quite absorbed, take out, and, after allowing to cool, place in it the medal as before, and surround the sides of the mould closely with cardboard, leaving about $\frac{2}{3}$ in. all round, above the face of the mould, and tie it tightly on. Then make a hole through the cardboard to the medal for the conducting wire on the face of the mould. Insert the wire and pour on the plaster-of-paris level to the top of the cardboard. Leave to set afterwards, and, while still soft, tear gently away the cardboard and trim the plaster to shape. Again leave some hours to set harder, and after that separate the two moulds. Take out the medal and treat both moulds as before recommended, taking care to joint up properly with the blacklead to the conducting wires; then place both moulds in the bath, facing a copper anode.

A medal has been treated as the subject here, but most common objects can be copied in one of the ways described.

Sewing Machines: Repairs and Adjustments

Repairing.—The amateur cannot generally undertake a serious sewing-machine repair, but he can often, after study and experiment, effect a successful adjustment. When a broken or defective part has to be replaced, the duplicate should, if possible, be obtained from the maker or his agent, rather than attempting to make a new piece or getting a professional mechanic to do so. All that is necessary to improve a machine that works very stiffly is to apply paraffin freely, leave it for a time, and then apply lubricating oil; or the immersion treatment in a petrol-paraffin mixture might be tried, remembering that this will dissolve all the oil in the bearings. If this does not suffice, strip the machine of all fittings, carefully marking any parts that an inexperienced person might find difficulty in reassembling in their original positions; place all bright parts (not japanned ones) in water, add a good quantity of soda, boil them until quite clean, and wipe briskly with a clean wiper, afterwards polishing them carefully with emery-cloth, being sure to wipe off all emery dust before replacing the parts in the machine. The shaft bearing, etc., may be scraped with a scraper, or carefully cleaned out with emery-cloth, but if emery is used be sure to wash out the bearings with paraffin oil, otherwise the emery dust will soon destroy the surfaces of the bearing.

Taking Machine to Pieces.—In taking a machine to pieces, method and order will be of advantage. Notice carefully the whole construction before starting. First remove the face-plate and next the side of the arm or back-plate. Next take particular notice of the position of the cams and gear wheels, marking each in a way that will be easily recognised. If the cams, wheels, and gears are fastened in position by means of pins, find the large ends of the pins and mark the cam or wheel near to that end, so that it will show both the "time" of the part and the right way of driving in the pin.

Some cams and wheels are held in position by two screws, one a set-screw and the other a spot-screw—that is, a screw with a long tail that enters a hole in the shaft, in this way keeping the part in right "time." When such is the case, find out (by removing each screw separately) which is the spot-screw, and remove that entirely, but leave the set-screw loosely in the other hole; then there will be no difficulty in replacing the cam or wheel.

When parts are pinned in position, care should be taken in driving out the pins, which are generally tapered. For this purpose use a taper punch made of cast steel and tempered down to dark straw colour. Having obtained a punch the right size, turn the part until the small end of the pin is uppermost, and give it a sharp, firm blow with the hammer. Do not give three or four taps at a pin, or the result will be to burr the pin over and make it necessary to drill it out. Keep each pin in its own part. When gears and other parts require driving out, use a brass punch or drift, so as to prevent damaging the part. Scrape away any oil or dirt that prevents a part being removed fairly easily.

Reassembling. — To reassemble a machine, always begin with the needle and needle-plate. Use a perfect needle, see that it enters the centre of the hole in the needle-plate, and if it does not, reset the arm of the machine. When this is right, fix the shafts, cams, etc., in position, and try each movable part as it is fitted to see that it moves freely. If too loose, refit it, or replace it by a new part.

Tension Adjustments.—To secure a perfect stitch and keep very thin material from puckering is a difficult matter, and depends entirely on the careful fitting of parts and the skilful adjustment of a machine to the particular fabric. In the first place, it is essential that a machine should work quite freely, a point which is not of so great importance if a machine is used for rougher classes of work.

Machines used for domestic purposes like the V.S. (vibrating shuttle principle) often stand unused for weeks together, thus allowing the oil to corrode or gum up, and causing a machine to run somewhat heavily and unevenly. This, in an indirect manner, may affect the regularity of the tension, which is more noticeable on thin goods. Therefore it is important to keep a machine clean and regularly oiled. Many important parts are often overlooked during the oiling operation; in fact, many users of machines do not know how or where to oil a machine properly. Therefore Figs. 1 and 2 will be helpful, and besides showing the location of oil holes and parts to be oiled, the illustrations will serve as a guide to other machines. In these figures it will be seen that there are a number of parts to oil which could very easily be overlooked. When a machine has been out of use for a long time, the application of a little paraffin will cleanse the parts; afterwards lubricate thoroughly with a good quality machine oil. The shuttle raceway where the shuttle works should be wiped out with an oily rag. Any lint or dirt which has accumulated inside the shuttle at the nose end should be withdrawn, as such might retard the unwinding of the bobbin. It is imperative that the cotton pulls evenly—that is, free from jerks; this refers to the upper as well as the lower tension.

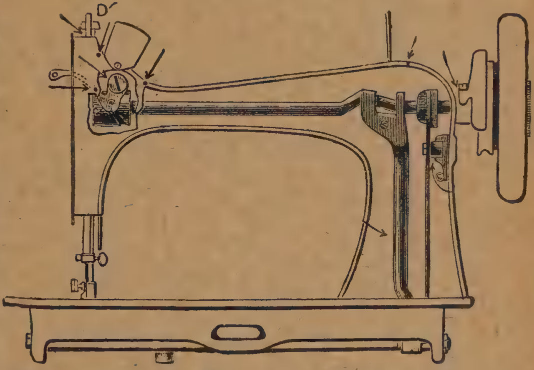


Fig. 1.—Skeleton Elevation of Vibrating-shuttle Sewing Machine

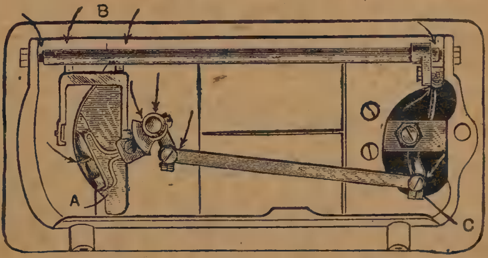


Fig. 2.—Underneath View of the Machine

For silk and similar materials best results can be obtained if fine cottons are used. Number 60, 70 or 80 would be preferable to No. 40. A good quality fine silk is even better. It must be remembered that when working on thin silk, say two thicknesses, the substance is such that will not permit a coarse cotton to be locked centrally. Fine cotton will need a fine needle, which necessitates a fine hole needle-plate.

If, after the foregoing points have been attended to, the machine runs easily, the parts fit properly, and there is no end play to the upper shaft and the cottons pull evenly, yet the tensions are erratic, attention should be given to the loop as it draws off the shuttle heel. In machines of the central bobbin (C.B.), oscillating shuttle (O.S.), and especially the V.S. class, there is a tendency for the loop to hang on the heel of the carrier, or become trapped between the shuttle and the carrier heel. In the two former types of machines the heel of the carrier should be rounded so as to induce the cotton to pass off as freely as possible. Sometimes it is necessary to time the shuttle a little later—that is, put the carrier back a little to allow the loop to draw off more in a line with the hole in the needle-plate.

In V.S. machines the carrier is already rounded off at the heel. By referring to Fig. 2 the action of the shuttle in the raceway can be seen, which is from A to B. The shuttle, having just entered the loop, is about to move to B. This movement can be regulated by an eccentric screw and nut C (Fig. 2). When a machine has been taken to pieces and cleaned, this screw is not always replaced to the best advantage. If the shuttle moves too much towards B, the loop is carried by the heel of the carrier, and at the same time the shuttle cotton, by bearing tightly on the needle-plate, pulls the shuttle towards the carrier heel, thus making it difficult for the loop to release itself. More tension is applied, perhaps more pressure is put on the take-up spring, yet the uneven tension is not overcome, and owing to the softness of the fabric it is drawn up or puckered. The remedy is to turn the screw C (Fig. 2) until the carrier is in a position to allow the loop a free exit.

For such soft materials as mentioned it may be necessary to slacken both tensions. It should be remembered that the upper tension is generally somewhat tighter than the under one, and this should be a guide to the adjustment of the latter, according to the fabrics to be stitched.

To prevent puckering when the tensions are correct, reduce the pressure of the foot by loosening the thumbscrew D (Fig. 1). Use a small size stitch—set the feed so that the teeth are just above the needle-plate. Do not have the teeth too sharp, and if necessary rub off the knife edge with "F" emery-cloth. Make the foot to bear squarely on the needle-plate, and the feed square to the presser foot. Round off all sharp edges from the underside of the foot, especially the back edge. Special feeders are made for silk goods in machines used for factory work, which overcome the difficulty of puckering.

By attention to the foregoing instructions a machine should work easily, especially if the fabric is slightly pulled from behind the presser foot.

In C.B. machines attention should also be given to the loop as it passes over the bobbin case and off the stop pin, it being necessary sometimes to round off the latter. Also, if the tension spring screw projects too high or is rough, it may occasionally catch the cotton.

It is well known that in oscillating-shuttle machines, particularly the older styles, there is a wide range in the amount of pressure or tension put on both the upper and lower cottons.

When any sewing machine makes a good stitch with both upper and lower tensions fairly slack, there is not much amiss with its adjustments. In fact, that is how it should work. But due allowance must be made for wear and tear on parts that govern and control the locking of the loops into the fabric, for if these do not work in strict harmony there must be a variation in the tension.

Sometimes a machine has to be repaired several times, and certain parts have to be fitted that need timing by a mechanic. Careful though he may be, it is quite possible that a vital part is not pinned in exact time with some relative part; and although the machine works well after the repairing, yet at a future time, when some other part needs replacing, trouble ensues.

As an illustration, suppose that a take-up cam is worn out, and a machine is sent to have a new cam fitted, and with a statement that nothing else is to be done to the machine. When fitting that cam, the mechanic times it a little too soon, and pins it in that position. Perhaps it is due to the hole in the new cam not being true to the old hole in the shaft. Anyway, it is left in that position, and the machine when tested works well, and no fault is to be found. Some time after the shuttle becomes worn out and is replaced by another; then the trouble begins. The upper cotton needs a great amount of tension to draw the loops tightly into the fabric, and, if thin goods are being stitched, this is annoying, as it may cause the material to pucker; or if poor cotton is being used, it breaks when the machine is worked quickly.

What has caused all the trouble? Not the new shuttle; it would be all right if all the other parts were in harmony. The question may be asked: "Why did the old shuttle work well?" Simply because it was worn in a manner that allowed the loop to be drawn freely round it. Therefore the difference in the time of the take-up did not, apparently, affect it; in other words, its looseness allowed it to adapt itself to the requirements of the take-up. Whereas the new shuttle fitted the raceway, and had only its proper amount of movement between the shuttle carrier, therefore it was imperative that the take-up lever gave out the slack cotton, and drew it up again in strict time with the shuttle. But, being a little too soon in giving out, it would also be too soon in taking up, causing the loop to bind whilst passing over the broad portion of the shuttle; or the loop might strand itself across the heel of the carrier, simply because it would be drawn up before the action of the shuttle carrier released it. Thus more tension would be needed on the upper cotton.

A new cover badly fitted to a beak-half shuttle might cause just the same trouble, likewise a carrier fitted in wrong time, or a rock-shaft connecting lever might be bent at too great a curve.

In adjusting, the aim should be to make the loop pass over the shuttle freely. In shuttles of the family machine type, the tension is usually regulated by means of holes placed in the side of the shuttle. These are not so convenient nor capable of such fine adjustment as the screw-and-spring type of tension in more modern machines. It will be found that some of these machines work very satisfactorily with comparatively slack shuttle tension, whilst others need a great deal more tension to prevent uneven stitching.

The fault may be due to faulty bobbins, or worn centre and spring, or the holes through which the cotton is threaded may be worn, or the spring on the shuttle side may nip the cotton too tightly, or vice versa. When irregularity of stitch occurs, it is well to apply a fairly tight tension top and bottom. If this causes trouble on light or thin fabrics, try a new shuttle. If then not satisfactory, it should be properly repaired, special attention being given to the time of the needle and shuttle, the adjustment of the slack thread pin which controls the check lever, and also the pressure of the check lever spring to ensure the loop being drawn up properly. Of course, the rapidity with which a loop is drawn up from the shuttle depends principally on the movement of the needle bar, which is controlled by a cam and roller. The cut of these cams varies in different machines. This affects the motion of the check lever, and consequently the manner in which the loop is drawn up.

Needles Breaking. — Breaking of needles is most generally caused by the needle touching and striking the needle-plate or the shuttle, and the first thing to do is to see that the needle is dipping quite perpendicularly. If it is not, take out the bar, get a new needle, and file out the groove until the needle does dip perpendicularly. This can be tested by holding a straightedge against the sides of the bar and holding both between the eye and the light. The needle should be parallel with the straightedge. When true, replace the needle-bar in the machine, and if the face-plate is adjustable—as in the Singer old style machines—adjust the bar so that the needle just clears the point of the shuttle; then adjust the needle-plate so that the needle clears the hole in the plate all round. The plate should guard the needle from striking the shuttle by being placed as close to the back of the needle as is possible without touching.

Sometimes needles are broken by the operator pulling the work along. This should not be necessary, as the feed should carry the work, except, perhaps, over extra thick seams. If the teeth of the feed have got low, raise the feed slightly, but not too high. When the work is pulled through by the operator, the needle is drawn on to the top of the throat-plate, so bending or breaking it. See that the feed is working properly, and is free from fluff and dust, which often collect in it and choke it up. Perhaps the needle-bar itself will be found to be bent, thus causing the needle to strike on the inside edge of the hole in the needle-plate. It can be straightened by striking it at its highest point with a light hammer while it is in the machine. Again, the shuttle, or shuttle race, or both, may be worn. thus allowing the shuttle to fall forward sufficiently to get on the wrong side of the needle—that is to say, the point of the shuttle passes on the outside of the needle instead of the inside. If the needle is adjusted to dip down in the centre of the hole in the needle-plate correctly, and the shuttle can be moved with the fingers enough to strike the needle instead of passing without touching, either a new shuttle must be procured, or enough of the point of the old shuttle, if not badly worn, must be rubbed off on a piece of emery-cloth to allow it to clear the needle.

Other causes of needles breaking are: needle-plate hole too small; edge of needle-plate hole too square (in this case bevel it with emery-cloth or countersink it with the point of a drill); needle too small, and so being too weak to withstand the strain; hook too late; shuttle or hook worn; shuttle carrier not guarding needle; roll pressure or foot too close to needle; needle-bar set too low. If the hook-case is adjustable, see that the hook is not set too close to the needle. A blunt point will cause breakage owing to its being unable to pierce tough material; blunt needles should be sharpened on an oilstone or thrown away.

Missed Stitches.—Of the various causes of machines working improperly, missing the stitch is the most common. A few of its causes are here enumerated. Bent or imperfect needle; bent needle-bar; needle not set straight in bar; needle striking the side of the presser foot or of the needle-plate; hole in needle-plate too large; needle too large or too small for cotton; not enough pressure on pressure foot; take-up spring acting too long; needle set too low or too high; shuttle too fast or too slow in its movement; shuttle point blunt or bad shape; shuttle or hook or roll presser too far from the needle. In some machines the shuttle or hook is made adjustable, but, when this is so, care must be taken not to set it too close to the needle. When the shuttle is not adjustable in this way, the arm of the machine must be moved. Before doing so, be sure the needle is straight, and the shuttle not worn so as to fall away from the needle; if there is any doubt about it, try a new shuttle. Much depends upon the shape of the shuttle or hook point. Most shuttles and hooks are made and finished by machinery, and are not all that could be desired as regards working qualities. Very often they are stunted and blunt at the point, and, though they may fit in a machine satisfactorily, are the cause of missing stitches owing simply to the shape of the point. A common reason for the thread not catching is that the needle is not properly set. A mark will be found on the needle-bar near the top. When the needle is set properly this mark should be on a level with the top of the arm, while the needle eye is on a level with the needle-plate. The needle should be straight, sharp, and large enough for the cotton. In every style of machine the back of the needle—that is, the short groove—should be towards the shuttle or hook. Also see that the needle dips perpendicularly. When the needle is too high or too low, the hook or shuttle catches the loop at the wrong place, and thus does not really get hold of it. Soaping the seams will often be helpful in preventing missed stitches.

Wood Inlaying

APART from inlaying as a branch of the veneerer's art (for which see a chapter in an earlier volume), there are two distinct methods of inlaying, the older of them being to inlay the pattern by cutting out the parts of the design in veneer and letting them into shallow depressions or recesses that have been cut in the solid wood; this method was employed during the Elizabethan and Jacobean periods. By the other method the design is cut from two (or more) sheets of veneer that have been glued together with a sheet of paper between them for easy separation, the pattern being then sawn out, as in fretwork, the two layers separated, the design portion in one wood being let into the background of the other, both being glued to a solid backing. This process is frequently called "marquetry," and is the simpler of the two, as the work of hollowing out the recesses to take the inlay necessitated in the older process is dispensed with.

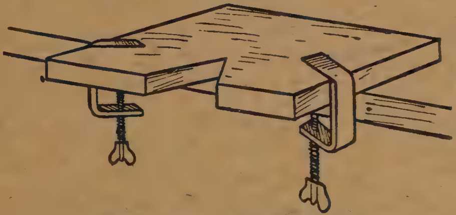


Fig. 1.—The Cutting Board

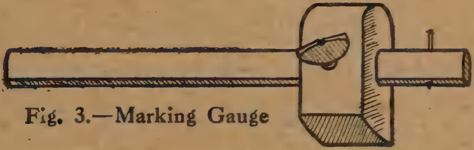


Fig. 3.—Marking Gauge

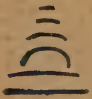


Fig. 2.—Chisel and Gouge Forms

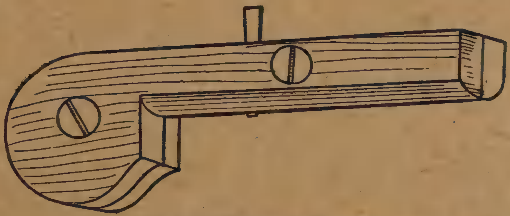


Fig. 4.—Scratch Stock

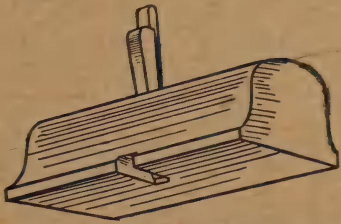


Fig. 5.—Router, or Old Woman's Tooth

Inlaying forms an interesting homecraft that may be pursued with very little expense. Its chief advantage lies in the effect producible by the simplest combinations of forms and its durability. It is by far the best method of decorating a plain wooden surface, which can be enriched at very little labour. The work is not laborious and is comparatively simple, providing due care is taken, and may be performed with ease upon an ordinary kitchen table, a woodworker's bench being unnecessary. This chapter will describe the various processes employed, and illustrations will demonstrate the various stages of the work.

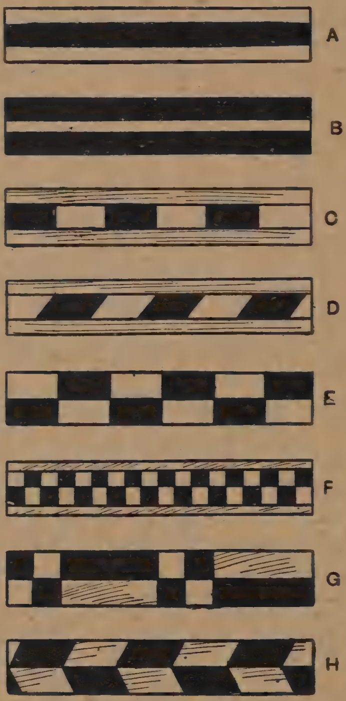


Fig. 6.—Various Stringings

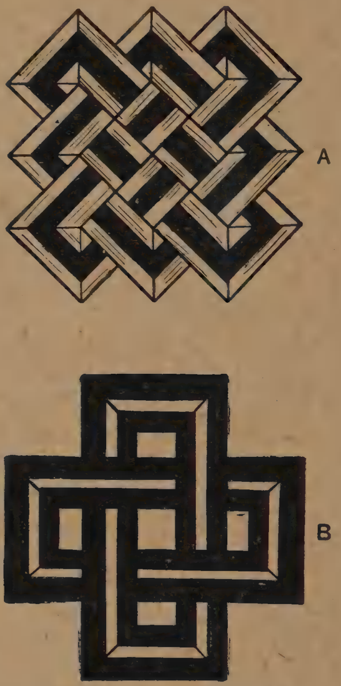


Fig. 7.—Two Geometrical Patterns

Tools.—The first consideration will be, of course, the tools and wood. The necessary tools for marquetry and inlaying resolve themselves roughly into two classes: those for sawing out the veneers, and those for sinking the shallow depressions into which they are inlaid. A good fretsaw and a set of gouges are the chief requisites (see an earlier chapter entitled "Fretcutting in Wood"), and a fretworker's cutting board will be found a great convenience (Fig. 1); any small board with a V-shaped opening cut in it will serve, and it should have a shallow depression cut in each side for clamping to the table; take care that the cramps do not project above the board and prevent the work lying flat upon it. The outlines given by Fig. 2 show the forms of six useful carving tools, comprising a chisel and five gouges, that would be sufficient for a beginner's use, but a larger range will be an advantage. To these tools must be added a marking awl, and a carpenter's gauge (Fig. 3) for marking out parallel lines for bordering panels, etc.

The scratch stock (Fig. 4), a special tool used for the purpose when the inlaid lines are not very wide, cuts the groove complete and dispenses with the chiselling out of the waste. It consists of two pieces of beech, or similar hardwood, screwed together with "gutter bolts," with a piece of hard steel set between, of the width of the required groove. By loosening the bolts the blade may be set in the required position in regard to the guide, and any depth.

A similar tool will be found most helpful in levelling the bottom of hollows, this being the "router" or "old woman's tooth" (Fig. 5). It consists of a piece of hardwood through which has been cut a square hole for the insertion of a piece of steel, which may be secured at any depth by means of a wedge, as shown. The under part of the router is level and meets the surface of the panel, the steel cutter working in the depression.

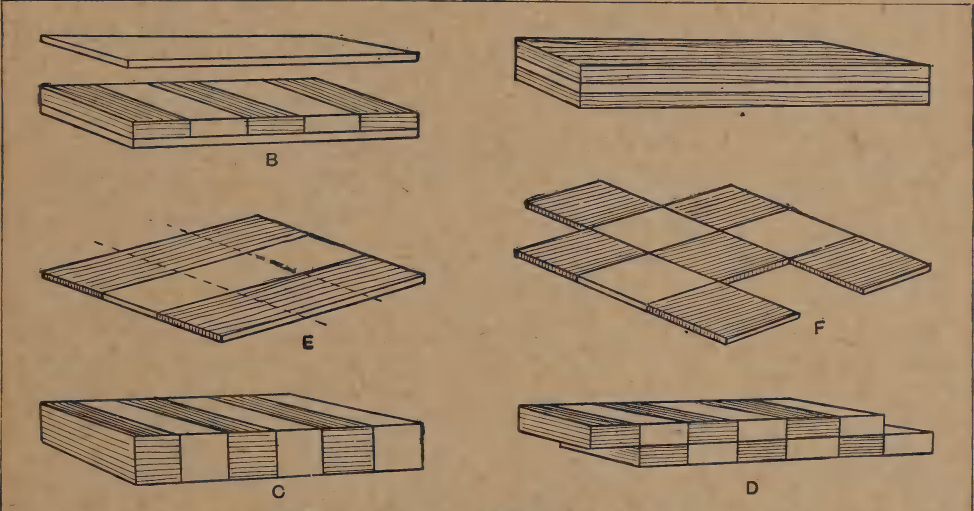


Fig. 8.—Stages in Making Stringing, etc.

Woods.—Almost any wood may be employed for the groundwork, the best undoubtedly being mahogany and walnut. Oak, being looser in grain, necessitates rather more care in the chiselling out of the hollows, but its pleasing grain will be found to contrast excellently with the inlaid veneers, and thus, in many cases, repays one for the little extra trouble. Satin walnut, bass, and lime may be employed where a light ground is desired, and will be found easy to work.

Wood for inlaying is in the form of veneers, of which there is a fairly wide range. A convenient thickness is from $\frac{1}{32}$ in. to $\frac{1}{16}$ in. The following colourings can be obtained in the natural woods: holly, white; pear, flesh-colour; box, yellow; satin walnut and lime, cream; mahogany and tulip, reddish colour; rosewood and coromandel, dark brown; ebony, black. Artificially coloured veneers in green, grey, etc., are procurable, but they are not recommended for important work, as they are liable to fade.

Glue.— Ordinary fish glue may be used for work on a small scale, being convenient to use and generally satisfactory, but it will not stand dampness. Hot Scotch glue employed thin is the best, and it needs to be carefully prepared. After heating, the scum on the surface should be carefully removed, and great care taken that no particles of grit get into the pot or upon the brush.

Stringings. — These are geometrical-patterned bands of various widths, a series of single forms of which are given in Fig. 6; they are cut as thin as $\frac{1}{32}$ in., and are sold very cheaply. Their chief use is for bordering panels and for building up patterns such as shown by Fig. 7. They are quite easy to make, but being so cheap, if any quantity is required, it is more convenient to buy them ready made. Straight bands, alternating light and dark, are made by gluing pieces together of the required thickness, to make the necessary width, as shown at A (Fig. 8), putting them under weights to harden thoroughly, and afterwards sawing into strips (see Fig. 9, a box with inlaying formed of the stringing shown being given in the same illustration). After sawing, the strips are finished with a smoothing plane. In example C (Fig. 6) narrow strips alternating light and dark are glued between a top and bottom layer B (Fig. 8); the edges of the strips in example D are planed to obtain the slope; in example E the easiest method is to glue up a series of strips of square section, as shown at C (Fig. 8), and then saw down in the *width*, gluing together again with the upper board moved along one (see D, Fig. 8). This is the method employed in making draught-boards, a series of strips being glued as shown at E (Fig. 8) and then sawn across, each alternate strip being moved a space in gluing down to the foundation (see F, Fig. 8). Examples F, G, H (Fig. 6) are produced similarly, one of the boards in the latter being turned round after sawing through, besides being moved along so as to obtain the slope of the lower portion of the pattern in the opposite direction to the other.

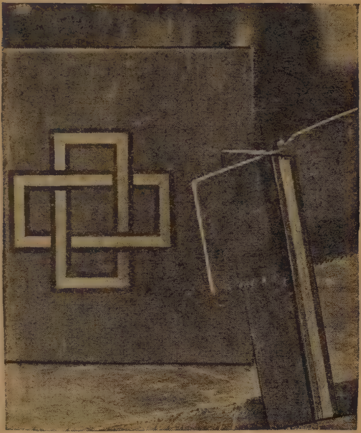


Fig. 9.—Sawing Stringings

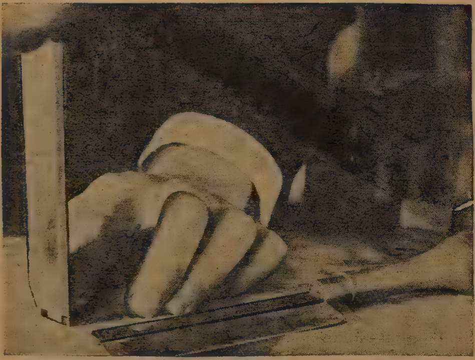


Fig. 10.—Chiselling End of Stringing

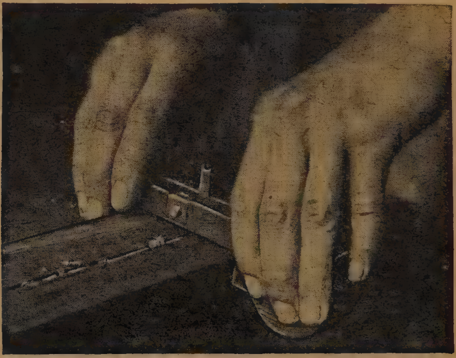


Fig. 11.—Using the Scratch Stock

Patterns Formed with Stringings.—There are innumerable geometrical patterns that may be built up with stringings, two simple ones being shown in Figs. 7 and 9. The first process in making is to set the pattern out carefully on the wood with square and compasses, taking especial care that the angles at the joints are accurate. In both the patterns given all the mitres will be at an angle of 45°, so after having obtained the length of any particular portion, strike a line across the stringing with a set-square, and saw through with the veneer saw shown in Fig. 10, the method of truing the mitre by chiselling so as to obtain an accurate fit being also shown. After the various outlines have been cut and fitted together on the pattern, the hollow for fitting them into is then chiselled in the board, a process that will be dealt with later.

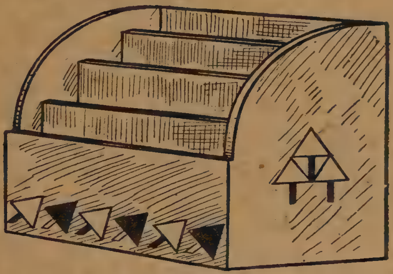


Fig. 12.—Inlaid Stationery Case

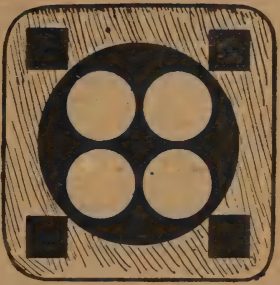
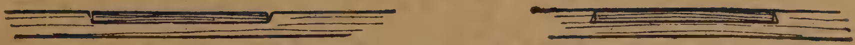


Fig. 13.—Inlaid Design for Box

The use of the scratch stock in cutting narrow grooves for inlaying fine stringing is shown in Fig. 11. The tool is worked away from the operator, and the chief care is to see that it is at right angles to the side of the board in the early strokes and that the guide is kept flush with the panel edge, as otherwise the blade will scratch the surface of the wood in wrong places, and so spoil it. When a channel is too wide to be cut in this manner, the best procedure is to use a cutting gauge with two blades to cut down the outside edges, and then chisel out the waste between, smoothing the ground with the router.


Figs. 14 and 15.—Incorrect and Correct Chiselling

Geometrical Patterns.—Next to the patterns formed of stringings come inlaid geometrical patterns formed of separate sections. Two simple examples of this class of work—a stationery case and a box—are shown in Figs. 12 and 13. The pattern of the former consists of a series of dark and light triangles arranged alternately, formed of ebony and holly respectively. After sawing out the necessary sections, and fitting them to the drawn pattern on the wood, in chiselling out the recesses make the first cut with the chisel *across* the grain, first in the centre of the space, so as to avoid the possibility of splitting the wood. Then cut with the chisel round each part to be removed, and clear out the waste.

A perfectly sharp outline being essential, it is advisable to employ a broad chisel, so that the cuts may be as few as possible round the outline, and in a perfectly straight line. The outside cuts should, if anything, slope slightly inwards, as shown in Fig. 15, rather than outwards, as in Fig. 14, when, of course, there would be a space round that would show up in the finished work. Having cleared out each space, the sections should be tried for a fit, and any necessary adjustments made by shaving off fragments with a sharp chisel. They are then glued in place with thin Scotch glue, or, for such small patterns, with fish-glue, and then set between two cauls—a top and bottom hardwood board—until thoroughly hard.

To inlay the pattern shown by Fig. 13, first inlay the large dark enclosing circle. Fig. 16 shows another effective but simple inlay pattern of a somewhat different geometrical form.

Small devices of this character form an attractive decoration for small articles of furniture, being more suitable in many cases than elaborate floral ornamentation, while taking much less time to execute. This particular design (Fig. 16) was inlaid in three woods—coromandel, holly, and ebony—set in a satin walnut ground, with excellent effect. In executing, the pattern is first drawn out on paper, from which the shapes of the light-brown and white portions are obtained and sawn out. The square in the middle of the light portion is not cut out at this stage, but later, when these parts nave been glued in. Fig. 17 shows the method of chiselling out the recess in the solid wood; notice the chisel cuts that are first made across the grain to prevent the wood from splitting. Gouge cuts are next made all round, and then the waste is removed with the chisel. Fig. 18 shows the router in use, the blade of which is set very slightly under the thickness of the veneer. It is held by both hands, as shown, and is worked backwards and forwards until the chisel blade has scraped away the requisite amount of wood. The sections of the inlay are now glued into place, and the work cramped between two cauls to harden, when the shape for the small black square is chiselled out and the square then glued in place. When gluing in sections of inlay, considerable pressure should be applied in order that all surplus glue shall be squeezed out, and that the sections may be in proper contact everywhere with the ground. A good tool for the purpose is the flat pane of a joiner's

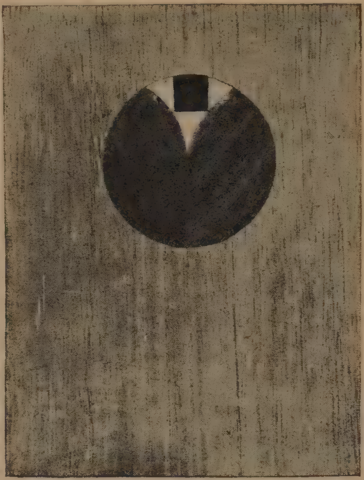


Fig. 16.—Simple Pattern

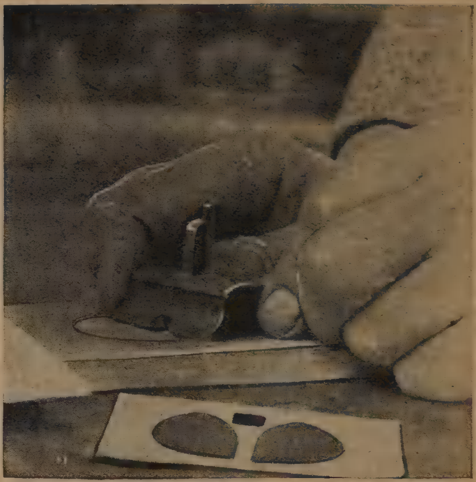


Fig. 18.—Using the Router

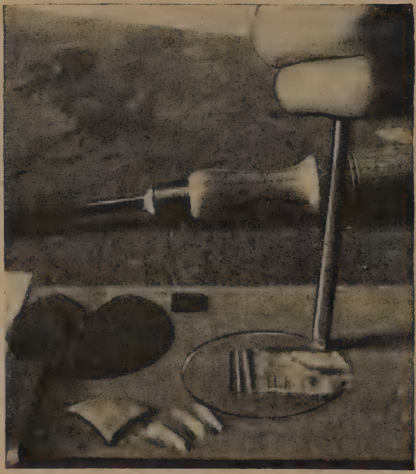


Fig. 17.—Chiselling Out the Recess

hammer in perfect condition, which is rubbed vigorously backwards and forwards over the work, thus squeezing out the surplus glue from underneath and filling up any fine crevices between the sections. Cramp up to harden, and leave the work at least twelve hours to set, when it is ready for cleaning up.

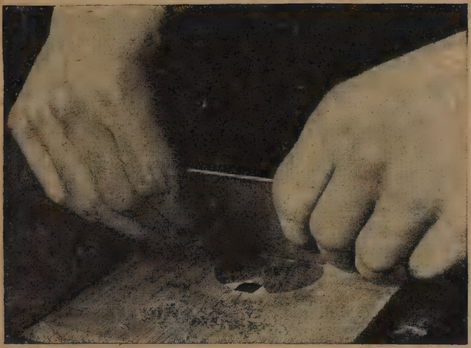


Fig. 19.—Using the Scraper

Fig. 20.—Using the Glasspaper Block

At this stage the work will appear very dirty, and possibly uneven, the inlaid pieces sticking out in some places more than in others. This inequality is corrected by means of a cabinet scraper, which consists of a piece of steel tempered to about the same degree as a hand-saw, a convenient size being about 5 in. by 3 in. The work to be scraped should be cramped to the working table or held against a bench stop or against a couple of screws, with the grain of the wood running towards the operator. The manner of holding the scraper is given in Fig. 19, this tool being worked away from the operator and held at a slope, the strokes being firmly made and repeated until the work is perfectly level. The sharpening of the scraper is an important matter which is fully dealt with in an earlier chapter.

Fig. 20 shows the finishing of the inlay with a cork glasspaper block, the rubbing being backwards and forwards in the direction of the grain, so that no scratches are produced.

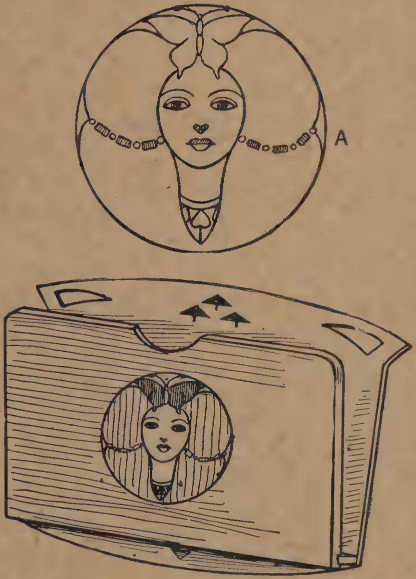


Fig. 21.—Inlaid Letter Rack with Enlarged Design A

Non-geometrical Patterns. — The next illustration (Fig. 21) shows a rather more ambitious pattern, set in a letter rack. One method of inlaying this kind of design would be to make the full-size drawing on the wood, as in the foregoing example, then take a tracing of the various portions, and transfer to the different woods. Saw out the main shapes first. The smaller details in the hair and below the neck are omitted in the early stage, these being cut out with a fine chisel when the large parts have been glued in. The features are inserted in a special way. They are first incised with a pointed tool that is not too sharp. The wood being holly, which is fairly soft, it will be found a fairly simple operation to make even shallow grooves and hollows which are afterwards filled with a dark-brown sealing-wax and scraped level. This treatment will be found quite a satisfactory one, and dispenses with the difficulty of dealing with minute fragments of wood. The small round holes in the hair are drilled, and small pegs inserted and cut off. Some workers, in a design of this description, prefer to cut out all the sections together, by gluing several pieces of veneer together with paper between each, when, upon separating, one part of the design will fit into another with great exactitude.

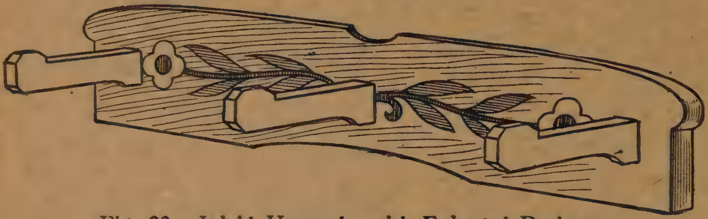


Fig. 22.—Inlaid Hat-rack, with Enlarged Design A

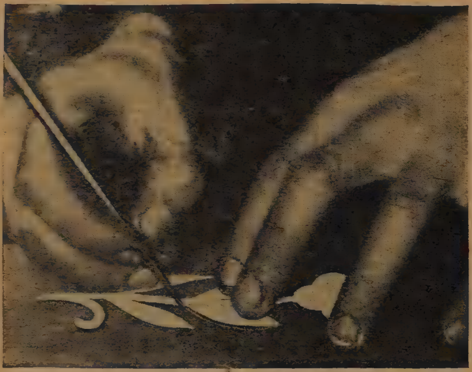


Fig. 25.—Marking Out the Shape

A hat-rack inlaid with a conventional floral pattern is illustrated by Fig. 22. This is a very simple example of a favourite style of inlay, the method adopted being the same as in the more elaborate designs.

Proceed by first making a full-size working drawing of one half; then transfer the various parts to the different woods, as before, three of which are employed in this particular pattern, omitting in the first stages the dark centre of the flower. The writer prefers to chisel out small sections, finding this a quicker and more accurate method than sawing, when the veneer employed is thin, except in the case of large forms. The sections are now pinned to a board, over the working drawing, in

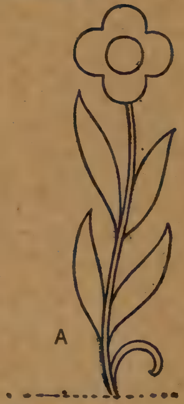


Fig. 24.—Pattern Covered with Paper

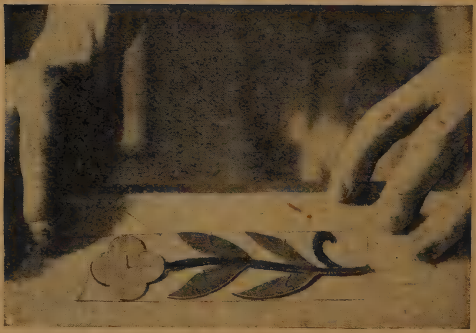


Fig. 23.—The Pattern Pinned Down

their correct position, with small dressmaking pins or fine veneer pins, as shown in Fig. 23. Now give the sections a coat of thin glue on the upper surface, and press down, over the pins, a sheet of paper in close contact with each part (Fig. 24). After drying, the pins may be removed, and the paper, with the sections attached, lifted off the board. With a fine pair of scissors, the paper is now cut away all round the edges right up to the wood. The pattern is now complete, held together by the paper, and it is a comparatively easy matter to obtain the shape for cutting the recess in the background by laying the paper-covered veneers in the correct position that the pattern is to occupy, and holding carefully down with the fingers whilst the shape is accurately marked round with an awl (Fig. 25). The shape thus obtained is then chiselled out in the ordinary way, the pattern being then glued in with the paper still attaching, this being scraped off when the glue has hard set. This method will be more particularly described in a later chapter devoted to veneering. There now remains the dark centre of the flower to let in. This procedure should be always adopted with patterns in which there are numerous sections to be let in a solid ground, for it dispenses with the necessary placing of each individual piece in its position on the ground for marking out, in which process one may very often go wrong, and even in simple geometrical patterns it is the best method for an amateur to adopt, unless the contained shape is of a very simple form, not requiring the fixing of small details.

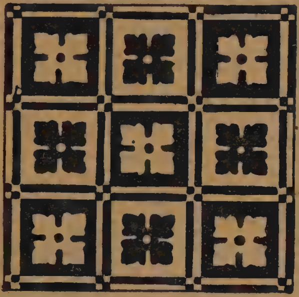


Fig. 26.—Interchange Pattern

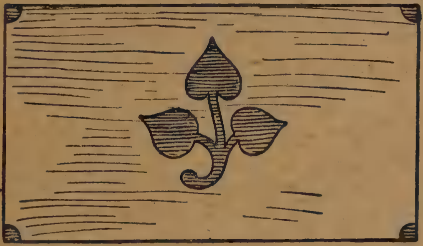


Fig. 27. Simple Marquetry Pattern

MARQUETRY

Mention has already been made of the method of marquetry, in which two or more sheets of veneer are glued together with the pattern on the uppermost one and the design sawn out, the sections then being separated and fitted together. It is a very useful method, especially where it is possible to have the background of veneer and in the case of interchange patterns, such as that shown by Fig. 26, in which there would be absolutely no waste pieces, what is left over in one square being used up in the adjoining one.

Fig. 28.—The Veneers Joined Together

Fig. 27 shows a very simple pattern inlaid in the marquetry method, while Figs. 28 to 32 illustrate the processes and the points to notice in the execution. Fig. 28 shows the piece of darker wood for the pattern glued to the lighter piece of the ground with a piece of paper between them, the pattern having been transferred to the uppermost piece. Drill in an inconspicuous place with the finest drill procurable, so that it will not mar the outline (Fig. 29). In sawing, slope the saw slightly inwards so that the upper piece will drop easily into the lower (see Fig. 30). After sawing out, the two portions will be separate (Fig. 31), and the veneers are separated from one another in each case (Fig. 32), and the pattern let into the light wood, both being glued to a solid ground.

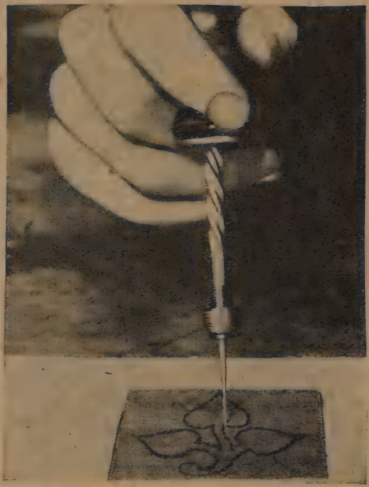


Fig. 29.—Drilling in Inconspicuous Place

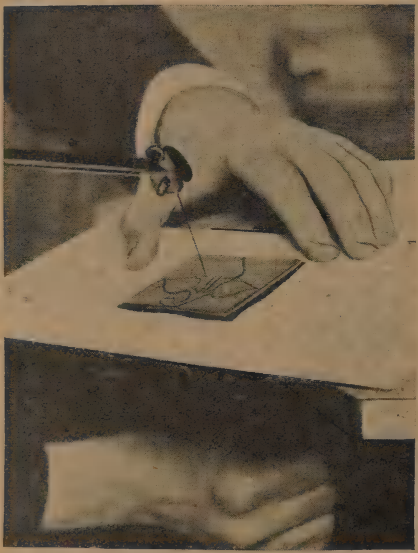


Fig. 30.—Sawing Out

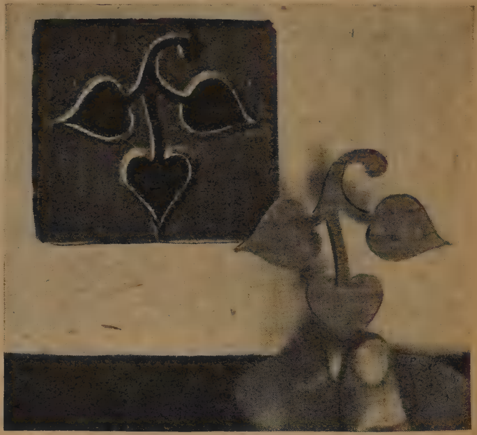


Fig. 31.—The Two Separate Pieces

Several layers of veneer can be cut together, if the design is in several woods, great accuracy of fitting being obtainable by this means. Fig. 33 gives a pattern in three woods that could be worked in marquetry, the fragments of ground being carefully laid on the working drawing as each is removed. Fig. 34 gives yet another pattern for marquetry cutting that would be productive of much effect if care is taken in the selection of the woods. The features can be executed in

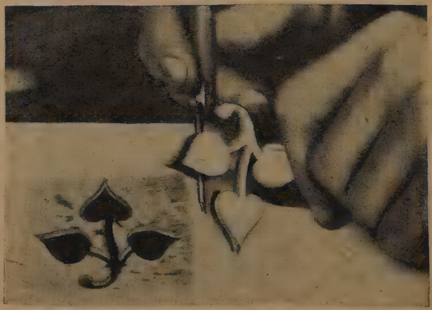


Fig. 32.—Separating the Two Layers

wax, as before mentioned, after making the necessary incisions.

Metals, such as brass or pewter, sometimes form the larger part of a marquetry design, in which case it is often called buhl work; whilst if only fine lines or bandings are used, the furniture thus decorated is called "Sheraton" or "Sheraton model."

Tarsia.—Some few years ago a style of inlay decoration called Tarsia came into vogue. In this work, instead of the veneer inlays being cut out with saws, they are shaped with scissors; instead, also, of the glue joints between the pieces showing as fine hair lines, these are opened out to about $\frac{1}{16}$ in., and the space filled in with a wax or composition that gives the work the appearance of being intertwined with a fine banding. Thus the work is built up with rather bold designs, mostly of a quaint character and employing a smaller range of colours than is common to most marquetry; yet in capable hands such work gives very fine effects. Suitable designs are presented by Figs. 35 and 36.

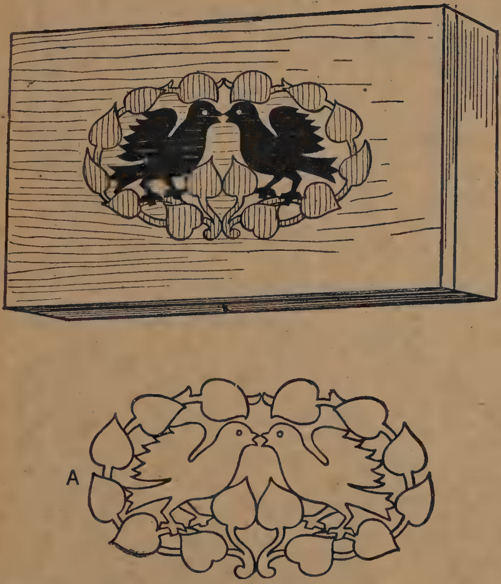


Fig. 33.—Inlaid Box with Enlarged Pattern A

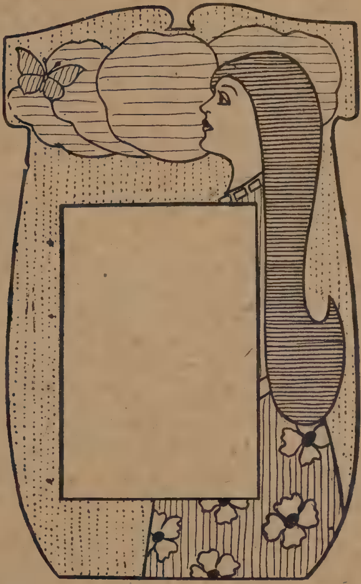


Fig. 34.—Inlaid Photograph Frame

Extreme precision in the fitting of the various pieces is not aimed at, for where in the ordinary cases a slight glue joint would be seen, a channel is cleared out with a V-shaped veiner or gouge, and filled in with a colour composition which forms an outline of distinct contrast, slightly thicker than a glue joint would appear. There is no shading or graduated tone as seen in choice examples of real marquetry, and the requisites are chiefly a stock of veneers, which may be in their natural colours, and also, for the sake of contrasts, in self colours, as green, blue, and black.

Ordinary nail scissors, straight and curved, or a sharp knife as used for cutting picture mounts, will also be wanted. There should be two copies of the design in hand, both exactly alike. One is traced on the article to be decorated, and the other kept handy and secured to a flat board by pins as a foundation copy. A copy of the original outlines can be readily traced on the article by means of a sheet of carbon paper and a hard pencil. Cut the outer banding or borders first, and place each piece of the foundation copy, filling in the centre as each piece is cut out. All the pieces should fit together like a puzzle, but leaving slight spaces. The pieces can be kept in position by driving the points of fine needles through them.

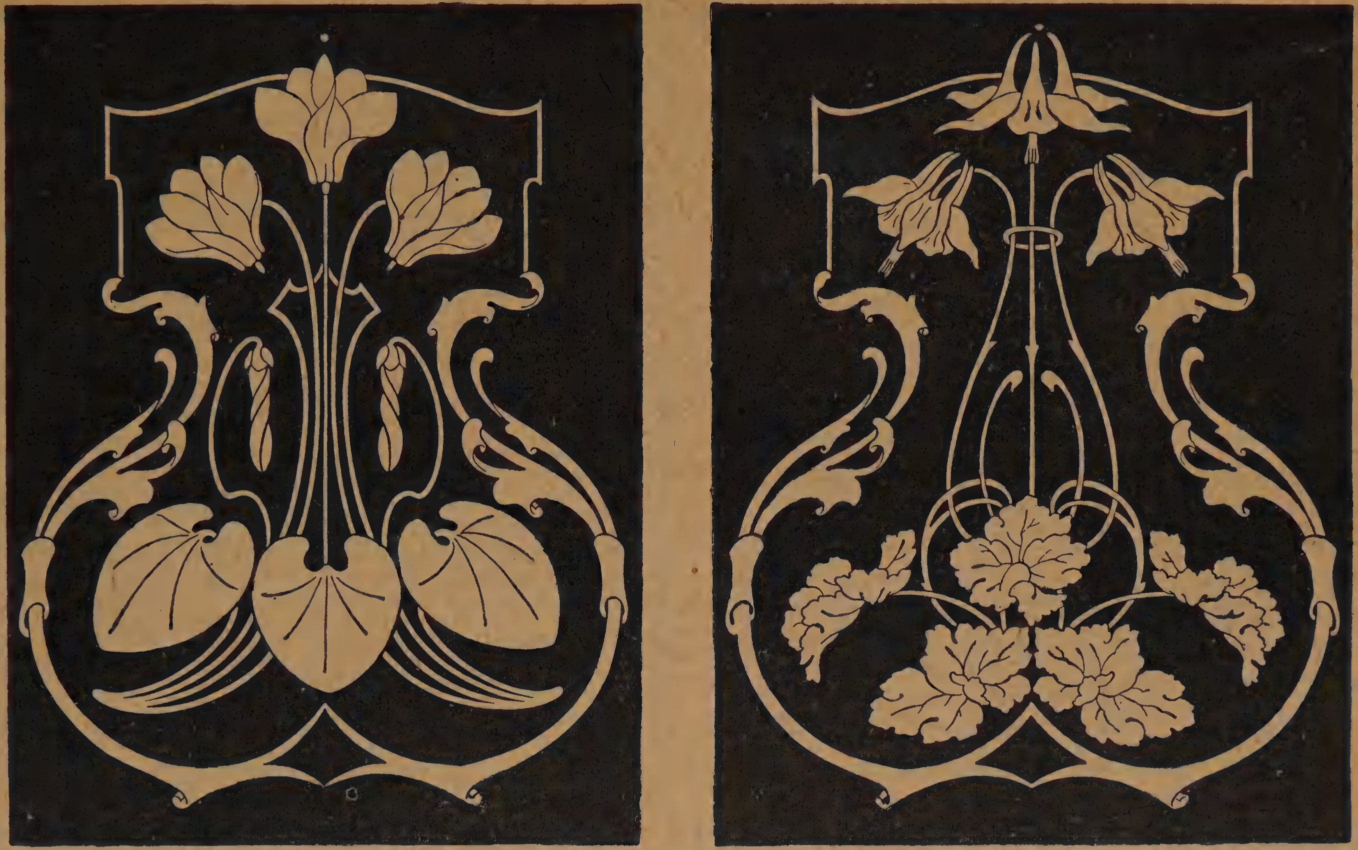
With a small hog-hair fitch, brush some glue on the wood where the veneers are to be placed, and transfer into position, piece by piece, each portion of veneer in its sequence, pressing down as the work proceeds with anything that is flat and heavy, and slightly warm. If the design is large, a small portion only should be treated at once, as the adhesive dries quickly, and it is important that each piece should set in its exact position as defined by the pencil lines. Allow a weight, such as a flat-iron, slightly warm, to remain on the work until the glue has set. If the work in hand is small, and weighting each portion separately can be avoided, so much the better; then, all the pieces being in position and covered with a piece of white paper, a flat board can be added, on which a number of books or weights of any description may be allowed to remain for at least twenty-four hours. Should any of the paper stick, it will readily be removed by rubbing with coarse rag, slightly damp.

The spaces between the veneers to represent glue joints should now be cleared out with a V-shaped carving tool, penknife, bodkin, or fine bradawl, and should be filled in with a composition of equal parts of plaster-of-paris and burnt alum powder mixed with white of egg to the consistency of putty, some dry colour, as vandyke brown, brown umber, or lampblack, etc., being mixed with it in sufficient quantity to impart a strong contrasting colour. Press it well into the interstices, scrape off the surplus, and set aside to harden.

IMITATION INLAY

There are several methods by means of which inlaid woods can be successfully imitated. Some painters get clever results by means of paints, but this style rarely lends itself to a french-polish finish; it is preferable to use wood stains, which, being very much thinner, strike into the wood instead of lying on the surface. When the work is to be done by stains applied with camel-hair or sable pencils, the designs are generally of a bold, striking character; but they need not appear crude. On the contrary, the very intricate designs call for a high degree of skill and artistic abilities that fall to the lot of few persons. Consequently for those who desire faithful copies of choice intricate designs of inlaid woods, some of them including pearl, brass, and pewter inlays, it is possible to obtain them in the form of transfers, printed on specially prepared paper, from which the designs can be readily transferred to any polished or varnished surface. Though, just as the real wood inlays are protected by the french-polish finish, so the imitation inlay is likely to give more satisfaction, and be the better protected, if it is fixed into position before the polishing is completed.

Imitating Inlays by Staining.—It will be desirable to confine early attempts to work easy of accomplishment. Good effects are obtained by introducing satinwood inlay on mahogany or walnut, and vice versa; boxwood or silverwood on rosewood; and maple on walnut. A good ground is formed by clean yellow pine, birch or whitewood, all of which take the stain well. Supposing it is desired to produce a mahogany inlay pattern on satinwood, the whole of the work is first stained satinwood, sized and varnished. Next the parts to be inlaid are given a coat of mahogany water stain. When dry, the pattern should be traced or "pounced," the water-colour worked over carefully with copal varnish or japan gold-size, and, when this is dry, the surplus water-colour removed with a sponge and water. A coat of varnish completes the work. In "pouncing," a perforated paper pattern or design is laid on the work, and the lines gone over forcibly with a muslin bag containing chalk or pigment. When a light pattern is desired on a dark ground the same method may be adopted, except that on the light stain, when varnished, the dark stain should be spread all over, and the pattern pounced as before; then



Figs. 35 and 36.—Two Companion Tarsia Designs with a sable pencil cut up to the pattern with gold-size, outlining it but not overlapping it; or, as the bulk of the ground is to be dark, copal varnish may be used. When this is hard, wash off the unprotected parts (the light pattern) with a sponge and water. The work in both instances will, of course, require after-varnishing. Work done in the manner suggested will give clear, sharp edges; but owing to the wood being varnished, the dark stain will not be able to penetrate the grain, so that the stain would more correctly be a glaze. The following method would not be open to the objection just mentioned. Instead of sizing and varnishing the wood, pounce the light pattern and go over it carefully with spirit varnish, that is, white hard varnish. This is a rather troublesome medium to work with; but attention must be given so as to ensure the pattern being satisfactory before proceeding farther with the work. The spirit varnish is soon dry. Now take water-stain and fill in the dark parts. When this is dry, the spirit varnish can be removed by moistening with methylated spirit and gentle rubbing with a wad of cotton-wool. The result is a light pattern and a dark ground.

Where a better effect is desired the dark pattern on a light ground may be outlined in any suitable colour, and where applicable an ebony or boxwood line is worth the extra trouble. A fine sable writer pencil will be the most suitable tool for doing this work.

Venetian Marquetry.—The following are hints on a simplified process of imitation marquetry, sometimes called Venetian marquetry. The outlines are formed of coloured wax, which gives the finished work an appearance somewhat resembling the tarsia previously mentioned. The wax outlines are generally brown or black, and though intended primarily to give the appearance of strongly defined glue joints, their real object is to prevent the stains from spreading or giving a ragged appearance.

Hard, close-grained woods, such as holly, larch, or sycamore, are most suitable. Being nearly white in colour, such woods allow of white or yellow being introduced into the design, whereas dark-coloured woods, even if harder, do not readily lend themselves to much variation of colour in the design. Canary wood (American whitewood) comes in handy owing to its great width, especially if the darker varieties are selected. It cleans up well, and its only apparent drawback lies in the fact that some of it is rather soft, and soaks up a lot of stain unless specially prepared. How best to prevent this suction depends in a great measure on the kind of stains intended to be used. If they are water stains, give several applications of water in which rice has been boiled or isinglass dissolved, or apply clear solution of patent size, to the work after it has been planed up and papered with No. 1 glasspaper. Either of these solutions will cause the wood fibres to swell and probably come up rough. If so, all the better, as it can be cut down smooth again by using No. 0 glasspaper. Repeat, if necessary, until the solution fails to cause the surface to swell up rough. This swelling and smoothing down again will enable the fibres to be so pressed down that on the application of water stains they will dry out, leaving a smooth surface. Similarly, if spirit stains are intended to be used a thin solution of transparent polish or a polish made from bleached shellac may be used with the same object in view—that is, to prevent the work coming up rough on the application of stain. Though these directions are given as applicable to canary wood, the same routine will be effective on other woods, such as holly, larch, sycamore, etc.

The wood being thus prepared, the desired pattern must be drawn on it very distinctly in black lines. Then with a sharp penknife go over these lines, incising them to the depth of nearly $\frac{1}{8}$ in., and keeping the lines of uniform width. Melt some beeswax in a tin, add some brown umber or gas black, and when nearly cold it can be taken up and rolled into a ball, in which form it can be rubbed into the incisions. If preferred, it may be applied in a liquid state by keeping it warm and pressing it in with a chip of wood. Rub the wax well in with a piece of rag folded up quite firm, and clear the surplus off the surface of the wood by rubbing lightly with a worn fine glasspaper. The object of this wax is, as before explained, to give the work the effect of being built of separate pieces, and prevent the stains from running into each other.

Staining may now be proceeded with. Wood stains are now obtainable in very attractive colours. Powder stains can be made up rather stiffer than the liquid ones, and are thereby less apt to run. The different colours must be laid on very carefully, and several applications may be necessary before the work appears solid. Spirit stains made by dissolving aniline dyes in spirit and adding one-eighth part of french polish or spirit varnish to act as a binder may be used instead of water stains if preferred, though it will be wise to strain the stains through rag or muslin before use. The process of staining should not be hurried, each coat being allowed ample time to dry before the next is applied. When all is dry wipe over with raw linseed oil, and proceed with the polishing, using a polish made from bleached shellac.

White Enamel Finish on Furniture

For enamelling furniture a pure white colour, it is first necessary to see that the wood is perfectly clean and free from polish or varnish of any kind. If already polished, etc., the coating must be entirely removed to enable the whiting foundation to have a key by sinking into the open grain. Assuming the woodwork to be quite new, it should be coated over with gilders' washed whiting mixed into a paint with double size—not the common variety made by diluting common glue, but a good transparent brand, such as Young's or Stephen's. When this is dry, fill up all nail holes amd other defects by using some of the whiting composition much stiffer. When hard, level off with glasspaper and apply a second coat of whiting and size. When hard, paper down again and brush free from dust.

Before applying the enamel it would be well to decide whether it is going to be a bought, ready-prepared brand, or a home-made preparation, and whether a bright or dull finish is intended; or if oil or spirit varnish is to be used.

Unless otherwise specified, a white enamel of the oil-varnish class gives best results with a minimum of trouble. The chief drawback against its use lies in the necessity of using a bristle brush of first-class quality (not a camel-hair one as french-polishers use for spirit varnish enamels), and the time it takes for each coating to harden before the next can be applied. A first-coating preparation which dries dead and forms a capital foundation for the enamel proper is sent out by some varnish manufacturers.

If the cost of the foregoing treatment is considered excessive, and spirit varnish and french polish must be used, then a white surface must be built up by mixing finely ground flake white (zinc white) in polish made from bleached shellac, commonly called white polish. The mixture will require straining through muslin before using, and many applications will be required before a perfectly solid body is gained. If a dull finish is required, a coating of transparent polish as a protective may be ample; but if a bright finish is wanted, then a coat of transparent varnish as used by polishers will be necessary. Also it may be necessary to use a trace of flake white on the face of the polish rubber when smoothing down as a means of preventing the work turning a yellowish tint. If a glaze is used it should be of the palest kind.

Orange-cutting Machine for Making Marmalade

THE following description is intended to serve as a guide only, since the materials at the writer's command largely governed the details of the finished article, and it is probable that a worker possessing other materials could with advantage modify the design to suit his case. The essentials are: (1) a barrel, through which the quartered oranges are fed; (2) a double-edged knife, pivoted to work across the mouth of the barrel; and (3) a framework. The barrel C (Fig. 1) is made from a porcelain jar 3 in. high by 1¾ in. inside bore. The glaze was nicked all round, the bottom chipped off with a cold chisel, and the edges then smoothed with carborundum powder on zinc. A glass bottle of about the same dimensions would do quite well, if the difficulties of cutting it can be successfully negotiated. The barrel stands in a hole in the board A (Fig. 1), and is also supported by the bridge B being set in both sockets with plaster-of-paris and gum.

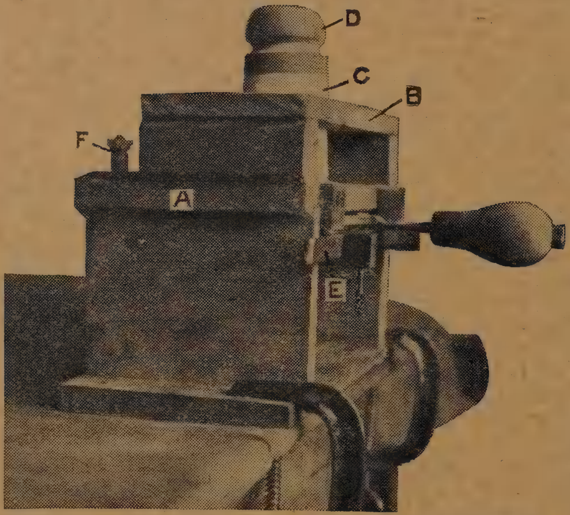


Fig. 1.—General View of Orange-cutting Machine

The board A is faced on the under-side with a piece of tinplate having a hole in it just the size of the inside of the barrel. It should be carefully flattened, and fixed to the board with ¼-in. wood screws whose heads are well countersunk, as it forms the surface against which the knife slides. A wooden stopper D slightly smaller than the barrel is used to feed the fruit on to the knife. The knife (Fig. 2) is made from a piece of steel 3½ in. by ½ in. by $\frac{1}{16}$ in.; a piece of a band saw was used, but an old ward file would be very suitable. For a distance slightly exceeding the diameter of the barrel, it is filed to an edge on each side, and at ¼ in. from the ends it is bored and countersunk (from the flat side) to receive two cheese-headed ⅛-in. bolts to attach it to the support (see Figs. 3 and 4). Using these holes, it should be bolted to a fairly stout piece of iron, and the whole heated to bright redness and plunged. Failing the precaution of firmly bolting it to a support, it will almost certainly warp. The knife may now be removed, polished with emery-cloth, and the temper drawn with a heated rod to straw colour on the cutting edges. The ends should be let down to blue round the bolt holes. After grinding on a stone, the blade will be complete.

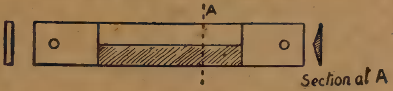


Fig. 2.—Knife of Orange-cutting Machine

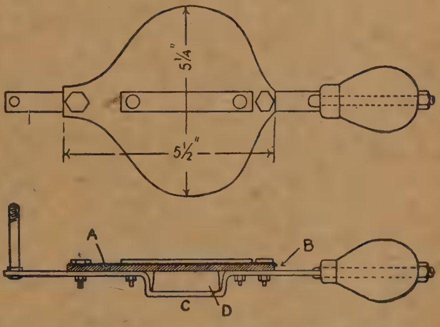
The knife support (Figs. 3 and 4) was made of three-ply wood (from a tea-chest) A, faced with tinplate B, and supported by a strip of ½-in. by ⅜-in. iron bent as shown at C. This arrangement could, of course, be well replaced by a piece of ⅛-in. iron plate, if available. The knife is bolted on through both shield and iron strip, and securely nutted. Its bevelled side is towards the shield, leaving its flat side to slide across the mouth of the barrel.

Beneath the knife the shield is cut away to form a window 2 in. by ½ in., through which the slices of fruit fall. The iron strip supporting the shield is bolted thereto at two points in addition to those in the blade, and is bent where it crosses the window, so as to give clearance to the fruit. It will be found necessary to bend a piece of tin D (Fig. 4) into a V-section, and solder its edges to the edges of the iron strip immediately below the window, so that the ridge of the V is in contact with the ridge along the centre of the knife blade. By this means the slices are thrown out from the same edge of the knife as they are cut by; otherwise it will be found that successive slices jam one another.

At one end of the iron strip is brazed a piece of ¼-in. round steel, passing through a wooden handle and nutted on the outer end.

The pivot F (Fig. 1) is a piece of ¼-in. round steel brazed to the iron strip, as nearly as possible at right angles, and subsequently coaxed into exact perpendicularity (see Fig. 4). In the writer's machine it is distant from the centre of the blade by 4½ in.; but this may vary with the diameter of the barrel and size of the shield. The only essential is that when the knife blade clears the edge of the barrel, the shield shall completely cover the mouth. The pivot passes through a copper tube (sliding fit) brazed to an iron plate, which is screwed to the board A (Fig. 1), so that the blade shall just travel across the mouth of the barrel. The projecting end of the pivot is threaded and nutted, and it will probably be found that some adjustment of height will be necessary; this may be obtained by means of washers.

The framework is arranged in most marmalade machines to have pivot and barrel horizontal, and the blade working in a vertical plane. The position shown in Fig. 1 is, however, to be preferred. As the knife must press fairly firmly against the tin-faced board A, there is some considerable sidewise strain, and it is well to fit the side supports in grooves (screw and glue), or to strengthen them with angle irons. To avoid great width these side-



Figs. 3 and 4.—Plan and Elevation of Knife Support pieces were slotted near the top to allow the tips of the shield to penetrate when in extreme positions.

Since the knife has to be kept in close contact with the tin, a guide must be arranged. A piece of iron E (Fig. 1) rests in two slots in pieces of wood projecting from the framework, and is secured from sidewise motion under the friction of the knife support by means of a pin. An extension of the side-pieces of the framework would be more convenient than attaching special strips. Wooden stops should be fitted to the edge of the board A, to stop the motion of the handle when the knife blade clears the barrel. For cleaning, this bar is removed, the nut at the top of the pivot is unscrewed, and the knife support dropped and withdrawn.

In fitting up, care must be taken to arrange the height of the guide in front and the pivot behind, so that the knife is pressed firmly and uniformly against the tin-faced board A. To get it to swing truly it will probably be necessary to pack the iron plate to which the pivot-tube is brazed. Sufficient length of the iron strip on the knife support must be allowed between the wood of the shield and the handle to run comfortably on the guide.

In use, the machine is firmly clamped to the table, and the oranges, cut into quarters and with the pips squeezed out, are fed down the barrel while the handle is worked backwards and forwards.

Reproducing Coins and Cameos in Plaster

THE casting and reproduction in plaster of coins, medals and cameos is a simple operation which requires extreme care, in order to ensure perfect results. The following method has given highly successful results.

Melted paraffin wax is used for casting. The ordinary quality does not give really clean impressions, therefore some paraffin wax of the hardest quality, obtainable at certain chemists under the name of "paraffinum duriss. opt.," should be used. This is melted, and, in cooling, kneaded between the fingers constantly, in order to keep it moderately soft, as it hardens very rapidly. Worked into a small slab slightly larger than the casting surface of the coin or gem, a final smooth surface is superimposed by immersing it momentarily in the semi-boiling wax and then allowing to partly cool.

Whilst still malleable, the slab is laid on a flat surface, and the impression taken with firm downward pressure of the gem. When cool, the cameo is released, and the result will probably be a bright, clean impression. The least fault in the mould should be sufficient to condemn it.

In moulding certain copies already in plaster, a slightly different method should be adopted, it being necessary to moisten the surface of the plaster, and to release the wax before final cooling, in order to prevent breaking the original.

For taking the models, finest "dental" plaster-of-paris is used alone. Admixture with finest powdered glass, whilst to a certain extent hardening the casting material, gives a somewhat greyish tint to the final model, and is probably inferior to mixing with kaolin, china clay, or some other aluminous material. The actual process consists in building up a rough wall of damp modelling clay round the impression to a certain height, and applying the plaster in thin, creamy solution, allowing it to dry perfectly before attempting to release the impression. As an extra protection to the plaster model thus obtained, the surface may be impregnated with sodium silicate, or paraffin wax allowed to permeate the plaster by continuous heat. But both of these processes almost imperceptibly detract from the sharpness of impression, or, rather, definition, of the reproduction.

Rustic Furniture for the Garden

SOUND, durable material and firm construction are the two essentials in making rustic furniture for the garden. The skill required is not great, but a certain amount of aptitude for the work is of great advantage. The woodworking is of a simple nature, as will be evident from Figs. 1 to 13, which illustrate photographically a number of the principal joints. The usual household tools—saw, gimlet or hand drill, chisel, heavy hammer, etc.—will suffice for the work.

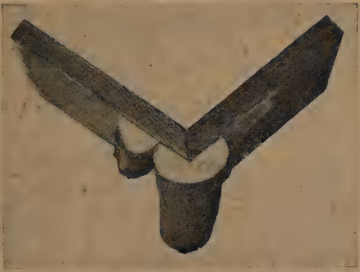


Fig. 1.—Joint Covered by Rustic Work

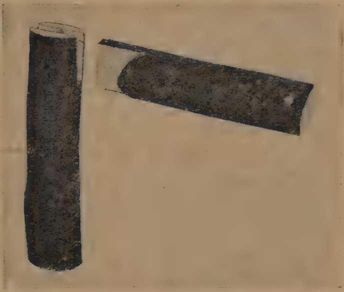


Fig. 2.—Open Mortise and Tenon Joint

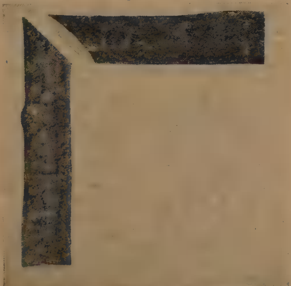


Fig. 3.—Mitre Joint

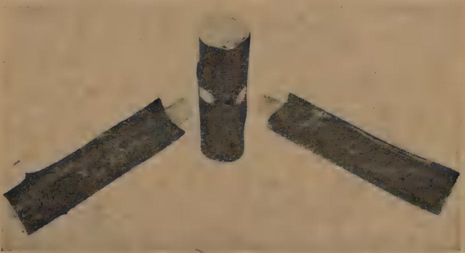


Fig. 4.—Dowelling Rails and Upright

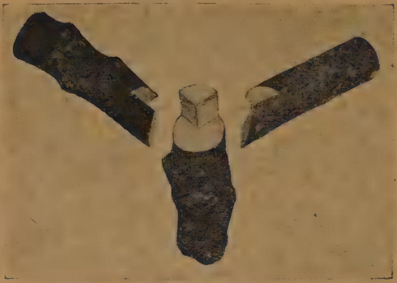


Fig. 5.—Jointing Rails to Post

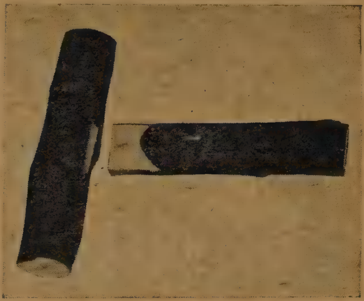


Fig. 6.—Mortise and Tenon Joint

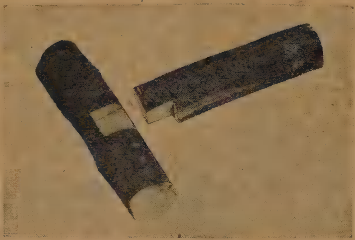


Fig. 7.—Housing Joint

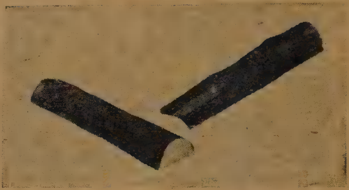


Fig. 8.—Strut Hollowed to Fit Rail, etc.

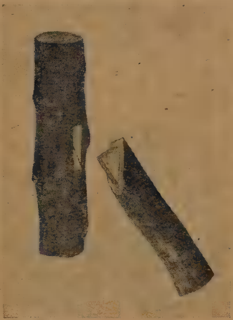


Fig. 9.—Tenoning Strut into Upright

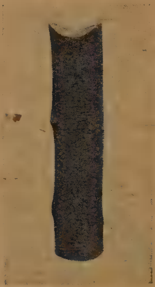


Fig. 10.—Rustio Member with Hollowed End

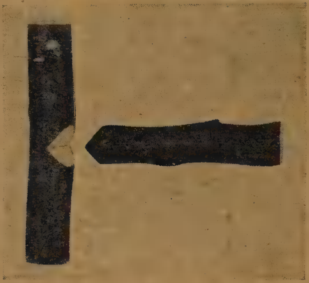


Fig. 11.—Notching Rail into Post

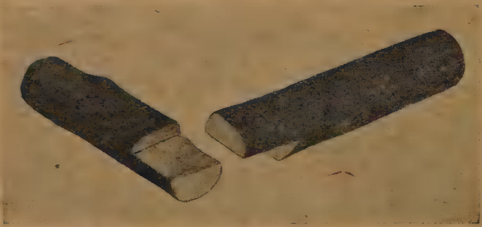


Fig. 12.—Halving Joint

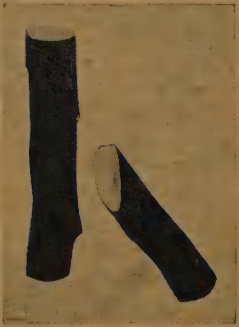


Fig. 13.—Strut Hollowed to Fit Upright

TUBS AND VASES

Hexagonal Vases.—A garden can be rendered very attractive by the display of shrubs and hardy bright flowering annuals in suitably designed rustic tubs and vases. Fig. 14 shows a hexagonal vase made of elm boards, and supported on the forked branch of a tree. The vase is covered on the outside with split branches or poles of a natural straightness. The wood may be oak, ash, birch, nut, or any sort of coppice wood that has been cut at least two years. The bark is removed in this instance, and the work finished in stain and outside oak varnish. Another kind of rustic covering sometimes used is fir poles and twigs with the bark left on. This class of work looks well for a time, but it has the disadvantage of shedding its bark, thus making bare patches. The native-grown fir is also less durable than the harder woods that are barked and varnished. A useful size for the vase is from 1 ft. 2 in. to 1 ft. 6 in. across diameters by 1 ft. or 1 ft. 2 in. deep. The sides may be 9 in. wide at the top edge and 7 in. at the bottom edge for an 18-in. diameter vase; the stuff should be of 1-in. elm board, which is recommended for its weather-resisting properties. Shoot the edge of the boards to the bevel gauge set at an angle of 60°, and nail the sides together (the illustration, Fig. 17, gives the idea). Shape out the vertical pieces of rustic wood to go over the angles and then cover the six sides or panels with diagonally placed split twigs or branches of suitable diameters, such as $1\frac{1}{4}$ in. to $1\frac{3}{8}$ in. Trim off any projections at the ends of the panels, and then fix the capping (see Fig. 15), which is cut from stuff $2\frac{1}{2}$ in. in diameter. Five equally spaced $\frac{3}{4}$-in. holes should be bored in the bottom of the vase for drainage. The forked branch of the tree which supplies the standard may be either nailed or, preferably, have a tenon formed on its end, to fit the base of the vase, and then securely wedged. Three upright twigs, $1\frac{1}{2}$ in. in diameter,

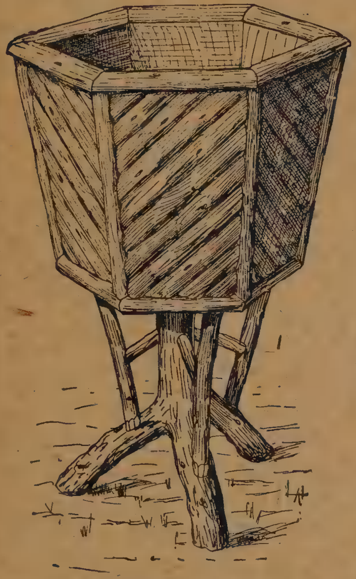


Fig. 14.—Hexagonal Vase on Stand

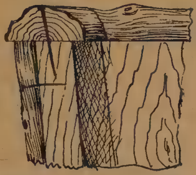


Fig. 15.—Section Through Part of Vase

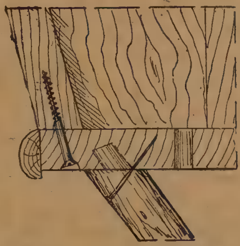


Fig. 18.—Securing Sides and Legs to Base

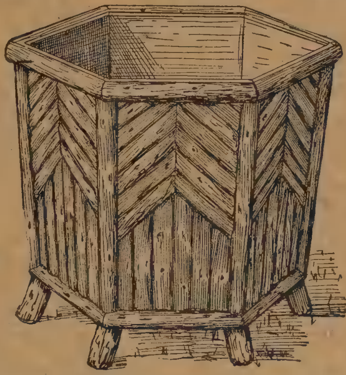


Fig. 16.—Hexagonal Vase on Feet

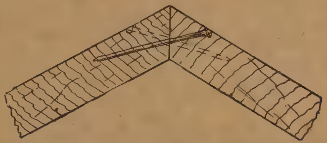


Fig. 17.—Joint of Side of Vase

are nailed to the legs and base of the vase as shown.

The vase is now complete and ready for staining. Mix some turps and linseed oil, and colour it with a little venetian red. Work in the stain thoroughly with an ordinary hog-hair tool, and when dry give one or two coats of outside varnish.

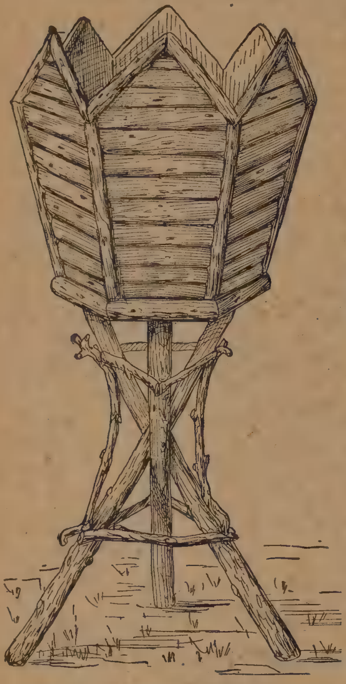


Fig. 19.—Vase on Tripod Stand

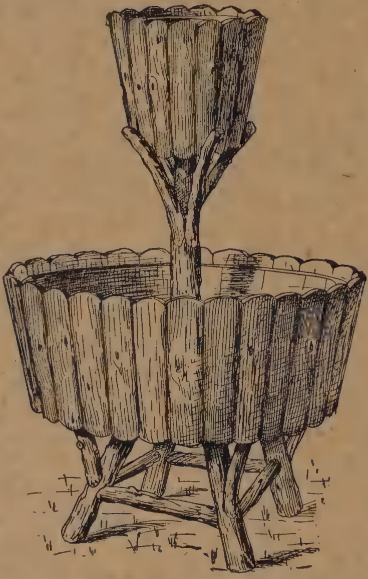


Fig. 20.—Combination of Two Round Tubs

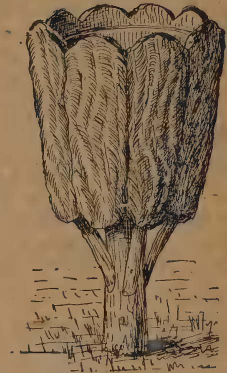


Fig. 21.—Round Stump Vase

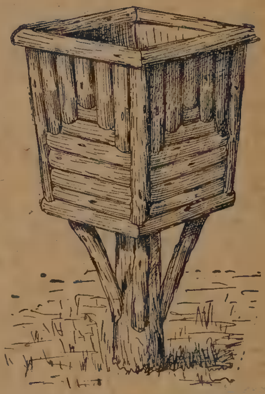


Fig. 23.—Square Stump Vase

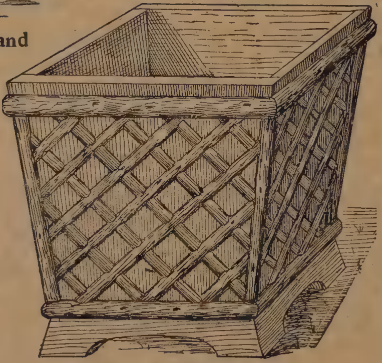


Fig. 22.—Square Vase

Another hexagonal vase is shown by Fig. 16. Its sides are 1 ft. 8 in. high by 1 ft. 2 in. wide at the top edge, and 1 ft. 0½ in. at the base. The sides and bottom are connected as in Figs. 17 and 18. Five 1-in. holes are bored for drainage. The short feet having been secured with screws driven from the inside, the split rustic work is bradded on in the same order as already described.

Still another hexagonal vase is that shown by Fig. 19; its vandyked sides are fixed to a base supported on tripod legs, and stands about 3 ft. 3 in. high. Elm boards are suitable for the sides and bottom; they are 1 ft. 3 in. high by 9 in. wide at the top end, and 6½ in. wide at the bottom by 1 in. thick. Shoot the edges of the boards to a bevel of 60°, and fix them with nails driven in as shown in Fig. 17. When the six sides are completed, prepare the hexagon baseboard to suit. Bore holes in it for drainage, and also bore three equidistant holes, 1¼ in. in diameter, at an angle of about 60° for the tenons of the legs to enter (see Fig. 18).

Next screw the base to the sides, and fix on the barked rustic work. The twigs for this should be seasoned at least one year before using. They are sawn in halves, straight twigs being selected for the purpose. If necessary, shoot the edges slightly, so as to obtain a closer fit when fixing them in parallel. Begin by attaching the lower border to the hexagonal base, then the upright pieces over the angles, hollowed as shown photographically in Fig. 1; fix the top sloping pieces, and finally the horizontal twigs. The legs are nailed at the base of the vase (see Fig. 18). At the centre, where they cross, they are further secured with twigs, which do the duty of rungs, as shown in Fig. 19.

Round Vases.—Fig. 20 requires but little description. A shallow tub is mounted on a low four-legged stool, the outside of the tub being covered with split twigs, which are rounded at both ends as shown. The edges are also slightly tapered to suit the batter, or inclining sides of the tub. On a central column, a smaller tub is supported and covered with split twigs in the same way.

A simple and effective method of constructing a row of flower vases along the edge of a lawn or garden path is illustrated singly at Fig. 21. A fair-size branch about 3 in. or 4 in. in diameter is let into the ground, which should be well rammed. A wooden bucket or a small cask is then mounted on the stump, and covered with cork bark. Drainage holes should be bored, and four small twigs nailed on to form brackets and improve the appearance of the vase.

Square Vases.—A square vase constructed from elm boards $1\frac{1}{4}$ in. thick is shown by Fig. 22. A fair size for the sides will be 1 ft. 8 in. at the top and 1 ft. 5 in. at the base by 2 ft. high, including the $2\frac{1}{2}$-in. plinth. The split twigs forming the decoration are $1\frac{1}{2}$ in. wide, and spaced about 2 in. apart edge to edge.

Another variety of the fixed or stump vase is shown by Fig. 23. It can be made any size, but 10 in. square at the top by 8 in. at the bottom by 10 in. deep will give a useful-size vase. The split twigs are only about $1\frac{1}{4}$ in. in diameter, and where the end of a twig comes in contact with another at right angles to it the end should be "hollowed" or pared away to suit, as shown in Fig. 8.

TABLES

Square Table.—The small rustic table shown by Fig. 24 can be used as a garden tea-table or as a flower-pot stand. The top may be of $\frac{3}{4}$-in. stuff, and should have two ledges nailed underneath to prevent twisting. The table may be 1 ft. 10 in. high, with the top 1 ft. 3 in. square, or, if a larger size is required, 2 ft. 1 in. high, with the top 1 ft. 6 in. square. The legs may be secured to the top by boring holes in the ledges and driving them in. The cross-bars must be firmly secured to the legs, and for the joints the mortise and tenon is suitable. If the sticks used to form the legs are rather small, it will be better if the cross-bars are

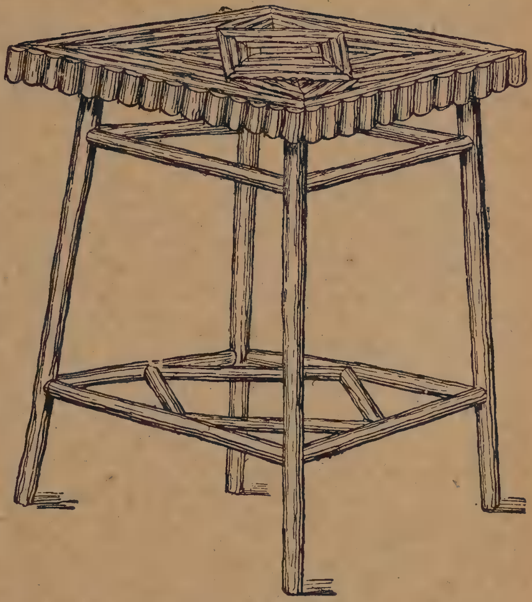


Fig. 24.—Square Table

kept a little higher on two of the sides, so that the mortises do not meet each other.

The top is covered with a Swiss overlay pattern, made of split sticks. The design may be set out by drawing lines from corner to corner on the top, and across the top in the centre of each side. A smaller square is then drawn in the centre of the top, with diagonals at right angles to the sides of the top. Lines drawn from the corners of the small square to the corners of the top will form a four-pointed star. The pattern should be clearly outlined with a pencil. In nailing on the sticks, those round the outer edge of the top should be put on first and mitred at the corners. Next the outside sticks of the small square should be nailed on, then the eight pieces from the corners of the small square to the corners of the top. In working up patterns of this description, always nail on first the sticks that follow the outline of the design. The filling-in pieces may be put on afterwards. Variety may be given to the patterns by using sticks of different colours; for instance, the design may be outlined in hazel or blackthorn, and filled in with hawthorn or peeled willow. The edges of the table-top are concealed by nailing on an edging of short sticks or cones.

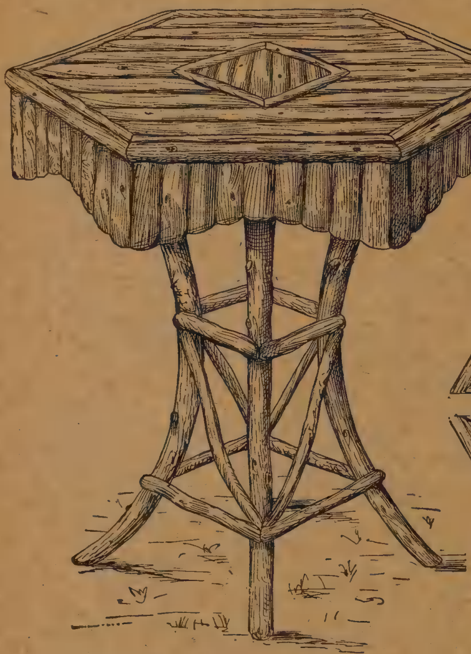


Fig. 25.—Hexagonal Table

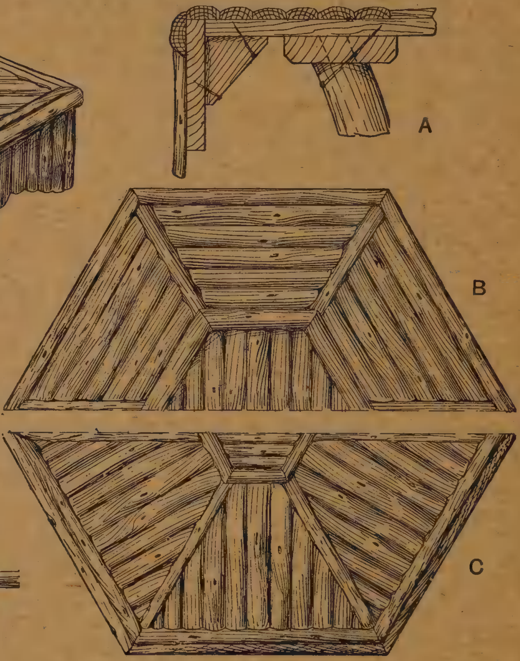


Fig. 26.—Table-top in Part Section and in Plan, Showing Alternative Designs

Hexagonal Tables.—For the table shown by Fig. 25, the following dimensions are suitable: height 2 ft. 6 in., and diameter of circle for the hexagon top 2 ft. 9 in. The top is made from two or three $\frac{7}{8}$-in. boards cramped together to he required width, and fixed underneath with two battens and further stiffened by the rungs and the diagonal braces which are nailed to the legs. A corona is fixed round the edges of the table-top, and the method of securing the board is shown at A (Fig. 26).

The half plans B and C (Fig. 26) show two ways of ornamenting the top. The twigs should be sawn so that in section they are less than a semicircle, and it will be an advantage to shoot their edges slightly, as then they will fit closer and cover the rough boards that form the table-top.

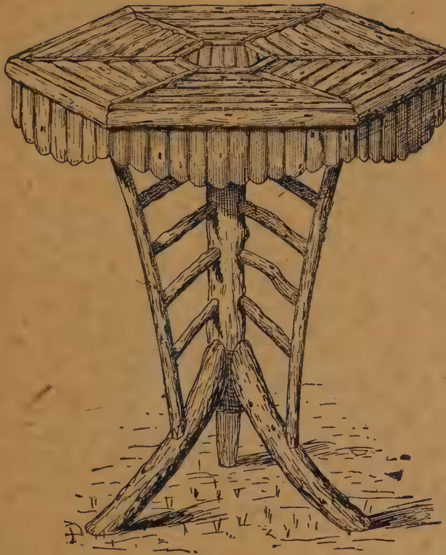


Fig. 27.—Hexagonal Table

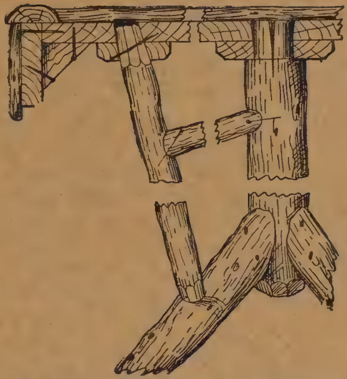


Fig. 28.—Part Vertical Section Through Hexagonal Table

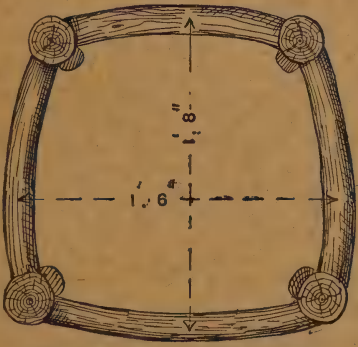


Fig. 30.—Plan of Seat Frame

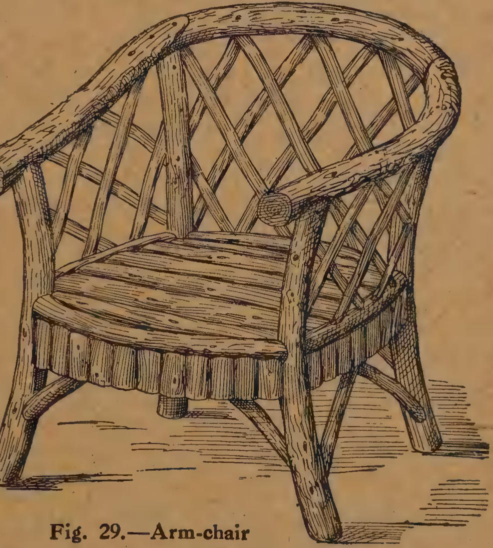


Fig. 29.—Arm-chair

Another table of hexagonal shape is illustrated by Fig. 27. The top is about 2 ft. 3 in. across diameters, and is made from 1-in. stuff, jointed with wood dowels and ledged on the under-side. The construction is practically the same as before (see the enlarged broken section, Fig. 28). The centre column, 1 ft. 6 in. long by 3½ in. in diameter, is tenoned and wedged to the table-top, while the three splayed legs are hollowed out roughly to fit the circumference of the centre column. The legs are bored to receive the uprights of 1¾-in. diameter, which should drive into both the legs and the ledges of the top. The legs can then be nailed to the centre column, and afterwards the ends can be trimmed off to give the table a uniform height of 2 ft. 4 in. The ends of the struts are slightly hollowed to fit both the column and the uprights. Begin with the lower strut and work upwards, nailing up as they are fitted to their respective positions. Next fix on the curved aprons and supporting brackets round the edges of the table, finally laying on the split twigs to one of the geometrical patterns illustrated.

AN ARM-CHAIR

For the rustic arm-chair shown by Fig. 29 select four slightly curved legs about 3 in. in diameter; the front pair are 2 ft. high and the back pair are 2 ft. 9 in. high. The front seat rail is 1 ft. 2 in. long by 2½ in. in diameter, and the back rail is 1 ft. long. The side rails are 1 ft. 3 in. long, their ends being trimmed to fit the legs, and fixed with inserted ash or elm dowels ⅞ in. in diameter (see Fig. 4). The height from the ground line to the seat top is 1 ft. 4½ in. The battens forming the seat rest on the side rails, and cleats are fixed to the inner sides of the four legs (see Fig. 30) to support the extreme back and front battens.

The arms and back are made in three parts, the scarfed joints coming immediately over the back legs. The trellis-work is then added, and finally the struts and dentils are fixed round the seat.

GARDEN SEATS

Shamrock Seat.—Fig. 31 gives the general appearance of a three-seated settee, or, as it may be aptly termed, a shamrock seat, made from fairly straight birch saplings, or pole wood as it is sometimes called. The wood should be well seasoned with the bark, and small twigs cleaned off neatly before it is ready for use. Fig. 32 shows the plan of the seats, and indicates the arrangement of the legs, back posts, seat bearers, etc.

Begin by cutting the three legs from poles about 3 in. in diameter by 1 ft. 1 in. long. Next cut three rails, 2 ft. 9 in. long by 2¼ in. or 2½ in. in diameter. Shape the tops of the legs and ends of the rails to make a joint as shown in Fig. 32, and secure the joints with nails. Next prepare three posts, with a natural curvature in them, to form the supports for the backs of the settee. These posts are lettered A, A^1, and A^2 in Fig. 32. Hollow the posts to fit the 2-ft. 9-in. rails as shown at Fig. 35. Then fix the seat bearers B, B^1, and B^2 (Fig. 32), and notch them to the outer rails as indicated in Fig. 35.

The seat boards should be of elm or oak, as they will be more durable than deal. Fix the boards to the bearers with a ½-in. space between them as shown in Fig. 32. This will give the seats a better chance to drain off rainwater under the covering of split-twig ornament than if they were a close fit.

Fig. 33 is a side elevation of one seat with dimensions, but with the outer posts removed. The central members of the back rest are halved to the back of the seat, and a short thick block C (Fig. 33) is fixed to give additional support to this joint. The three back members are worked down on their top inside edges to form a flat surface (see Fig. 34), and so make a joint which is afterwards securely nailed together. Next fit the struts as shown at D (Fig. 33). The lower end of the strut fits in a hole bored in the leg, and at the top end is secured both to the seat and the seat bearers B. The bordering round the seats is in short lengths, cut from natural curved stuff, and further curved on the inside edge with a bow-saw to suit, so as to get the same curve as the edge of the seat boards they conceal. Lap joints will look better than butt joints, as in the latter a nasty opening will be revealed on the wood shrinking.

Then prepare a quantity of split twigs about 1¾ in. in original diameter to form a rustic covering for the top of the seats. A suitable pattern is shown in Fig. 32, where the ends of the split twigs abut on a longitudinal twig. The ends must be hollowed to suit, as shown at Fig. 8. If the ends were left square, an unsightly space would be the result.

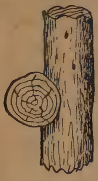


Fig. 35.—Post Hollowed to Fit Outer Rail

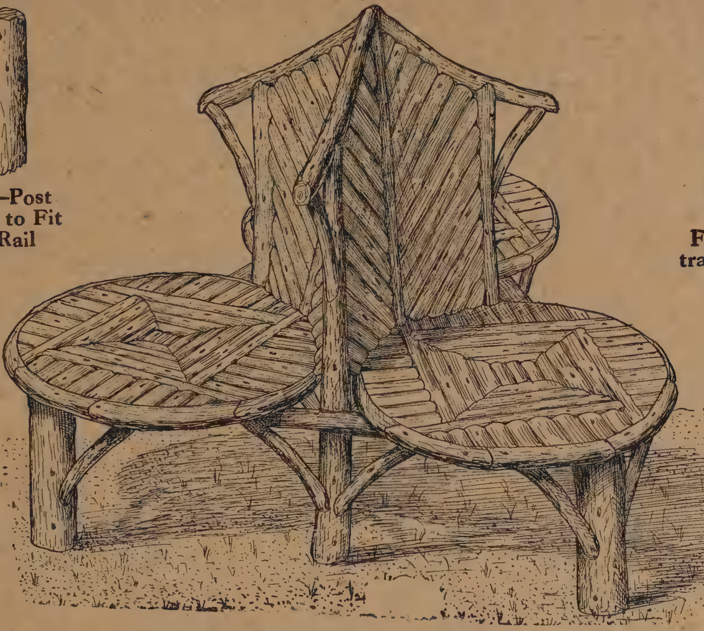


Fig. 31.—Shamrock Seat

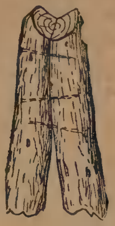


Fig. 34.—Central Members of Back Rest

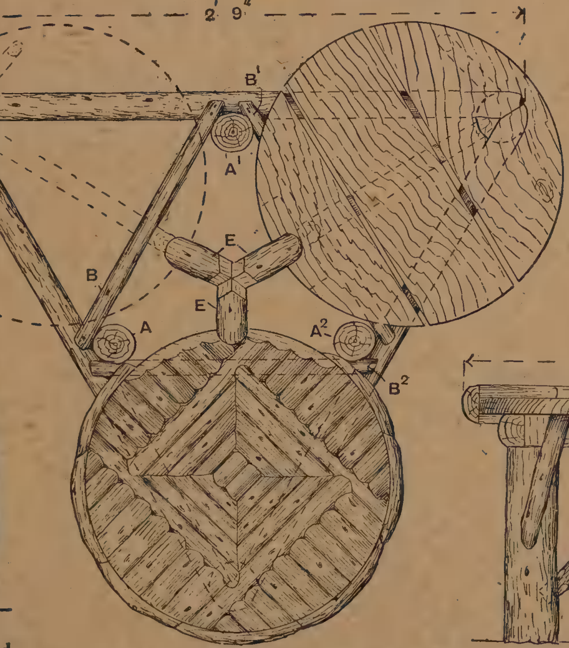


Fig 32.—Plan of Seat

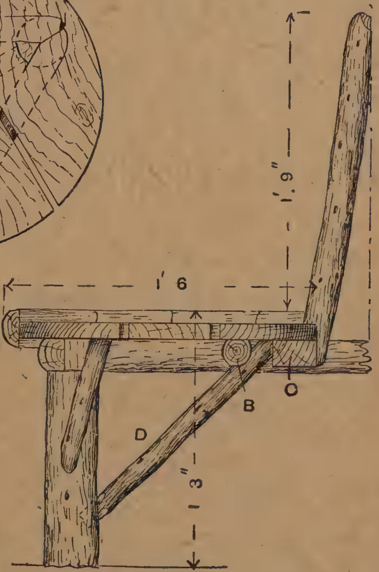


Fig. 33.—Side Elevation of One Seat

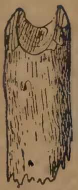


Fig. 36.—Post Hollowed for Top Rail

Next hollow the top ends of the posts and the tops of the tripod back supports E (Fig. 32) as shown in Fig. 36, to receive the top rails, and fill in the back panels with half-round stuff, paring the ends nicely to fit the posts, rails, etc. All that now remains to be done is the fixing of the struts under the top rails, and the outer pairs on each leg and lower part of the posts.

The settee should be finished with stain and varnish; two coats of outside oak varnish will be sufficient. Rustic seats, etc., should be stored in a dry, airy shed during the winter months, and coated with varnish each spring, well working the varnish into the joints. In this way their life and usefulness will be prolonged considerably.

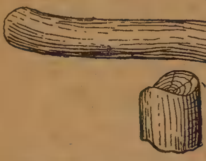


Fig. 40.—Arm-rest

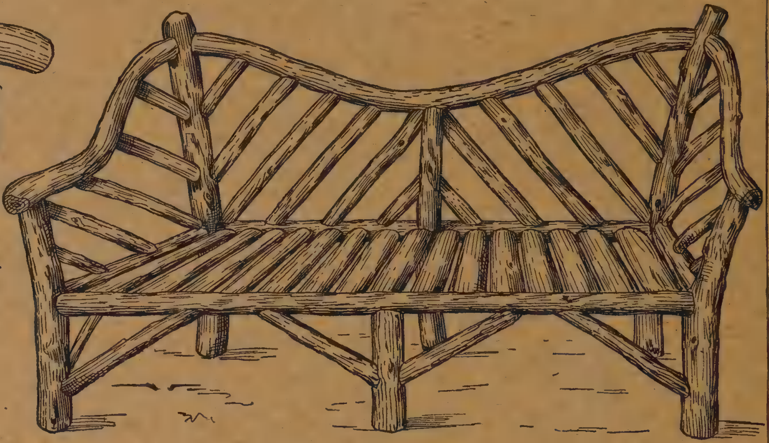


Fig. 37.—Straight Garden Seat

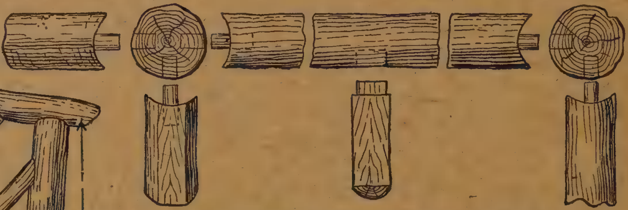


Fig. 39.—Joints of Rails and Post

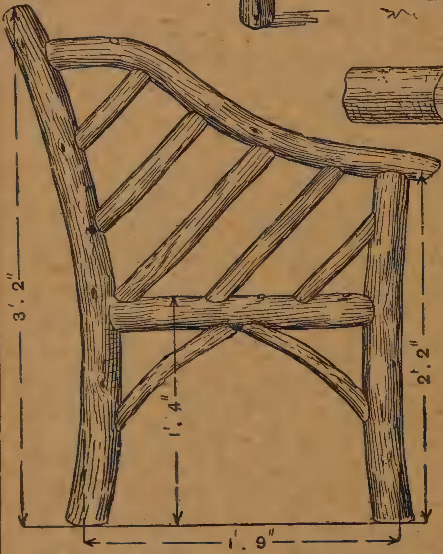


Fig. 38.—End Elevation of Garden Seat

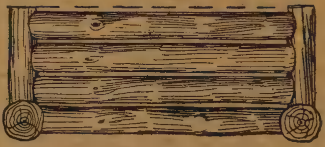


Fig. 41.—Part Plan of Seat

Straight Seat. — The garden seat shown by Fig. 37 will look very effective if made of oak that has had the bark removed and the small twigs trimmed off clean; they should be finished in stain and varnish. First select the three back posts, with their natural curves as much alike as possible. In diameter they should be from 2½ in. to 3 in. Select also two arm-posts and one centre leg for the front. Next cut two seat rails for the back and one rail for the front 5 ft. or 6 ft. long as desired, and cut two side rails (see Fig. 38) and one centre rail each 1 ft. 7 in. long. Work the ends of the rails to the shape of the posts as shown by Figs. 39 and 40, so that they make a fairly good joint, and bore the post and rails with a ⅞-in. bit 1¼ in. deep, to receive dowels made of ash or elm. Fit all together temporarily, and make good any defects. Then take the pieces apart, and coat the joints with a thick priming consisting of two parts of white-lead (ground in oil) and one part of red-lead thinned with boiled linseed oil. Drive the joints home and fix them with nails or screws and wipe off the surplus paint.

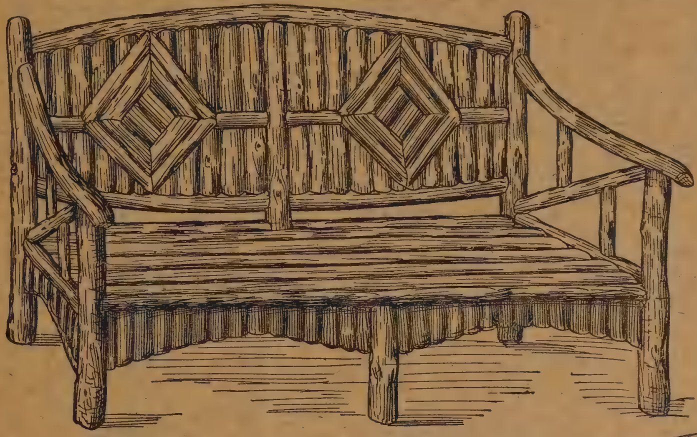


Fig. 42.—Garden Seat with Panelled Back

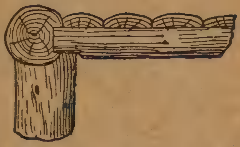


Fig. 44.—Vertical Section Showing Front Rail, Cross Rail, and Battens

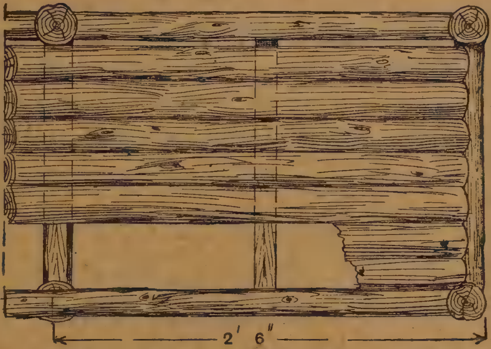


Fig. 45.—Part Plan of Seat

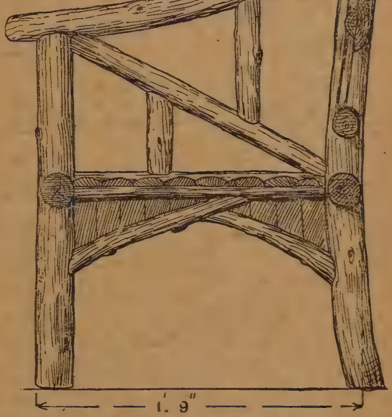


Fig. 43.—Vertical Section of Garden Seat

The top back rail and the arm-rest can next be fitted. The ends of the back rail are " bird's-mouthed " to fit the posts. The arm-rests are treated in the same way at the back; they fit in V's cut in the front posts, and are fixed with nails. Measure off and mark equal spaces for the struts, the ends of which are trimmed to fit the rails and posts. Secure them with two nails at each end. The seat (Fig. 41) is made up of split saplings bradded on. Finally, fit the struts between seat rails and lower part of the posts.

Straight Seat with Panelled Back.—The framework for the seat shown by Figs. 42 and 43 is on the same principle as the foregoing. The segmental battens forming the seat run longitudinally, and their ends are shaped to fit the outer rails. The battens rest on a flat worked on the centre cross rail. Fig. 44 gives a part cross section near the centre leg, and shows the front rail placed out of centre and the cross rail resting on the leg, to which it is firmly nailed. When the seat is more than 5 ft. in length the battens require intermediate supports, which can be cut from split saplings. The panelling on the back is fixed to the top and bottom rails and supported in the centre by a wide longitudinal rail and two vertical rails at the mitres of the diamond centres. These are fitted in and secured, and then the vertical split twigs are fixed partly on them and also on the rails. Finally, struts are fixed to the seat rails and legs and covered with short twigs, with their lower ends running in a regular curve.

The Siphon: How It Works

A SIPHON is, in its essentials, a bent tube whose shape somewhat resembles the reversed U, one leg of the tube being longer than the other leg. The siphon works automatically by atmospheric pressure; and when the siphon B has been filled with water instead of air, the short leg of the siphon is placed in a vessel of water as shown at A (see Fig. 1), and water flows immediately from the discharge end C of the siphon and continues to flow until the water is at the same level in both of the vessels (see dotted line D E). The tube may be a bent gas-pipe, or a length of indiarubber tubing.

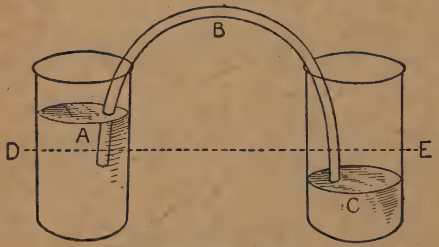


Fig. 1.—The Siphon

Essential conditions of the siphon's efficacy are that the discharge end C shall always be able to discharge below the level of the water A, that all air shall be excluded from the siphon and replaced with water, and that at about sea-level the height of the crown B of the siphon above the water that is to be discharged shall not exceed about 30 ft. (more or less according to the pressure of the atmosphere). As the height above the sea increases, the crown of the siphon must be lowered. The siphon is used for the purpose of transferring liquids from a high to a lower level, and forms a temporary and easily fixed channel by which any obstructive barrier between the liquid that is to be removed and the place or the vessel into which the liquid is to be discharged is readily surmounted.

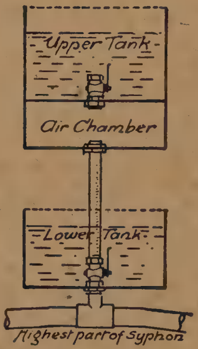


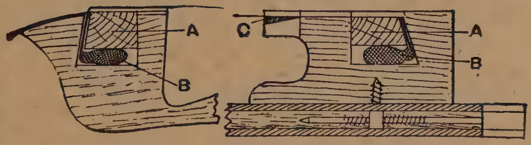
Fig. 2.—Venting a Siphon

Venting Water Siphons.—While the siphon is an excellent means of getting water from a high source to a low one, over an embankment, or for getting well water to a lower point, there is often a constant source of trouble through the high point of the siphon getting air in it—becoming " air-locked " as it is called. The simple device shown by Fig. 2, which may be home-made in stout sheet-metal, provides a means of discharging the air without emptying the siphon, or opening it, and, if care is taken, without letting the air stop the working of it. It will be seen that the device provides an air chamber, so that a certain amount of air may be allowed to collect without interfering with the water in the siphon pipe.

It will be seen in the illustration that there is an upper tank, a lower tank, and an air-chamber. There is a stop-cock in each tank. When the siphon is at work the upper cock is closed, the lower cock open. This allows of air rising from the siphon into the air-chamber—that is, it allows air to collect at a point which is out of, not in, the siphon pipe. At the proper time, the lower cock is first closed and the upper cock then opened. This releases any air that is in the air chamber, which is replaced by water which runs in from the upper tank. The closing and opening of the cocks is then reversed, leaving them as before, and no further attention is needed until it is considered that sufficient air for discharging has collected again. The water in the lower tank only serves to keep the lower cock sound or to admit of water being drawn in instead of air should the lower cock be a little unsound. If there was a certainty of the lower cock being always perfectly sound the lower tank could be dispensed with.

Re-hairing Violin Bows

In the successful re-hairing of violin bows (including also viola, 'cello, and bass bows) the chief points are: first see that the wooden blocks or wedges A that hold the hair B in position fit well in their recesses; and second, the hair must be carefully straightened and combed out before tying the loose ends. The accompanying illustration shows the shape and position of the wedges in the tip and nut of the bow.



Section of Bow Tip and Nut.

The first thing is to remove the old hair. This is done by taking out the tightening screw at the end of the stick; then take the nut in the left hand, and with a thin knife carefully work off the silver ferrule. Then the thin wedge C under the hair can be gently worked out, care being taken not to damage the top of the ebony nut, which is often very frail at this part. When the wedge is removed, a little forward pressure with the ball of the thumb will generally move the pearl slide, which is then easily withdrawn. The wedge that holds the hair in the nut should then be lifted out with a pointed tool or penknife blade and the hair removed. The wedge in the tip is taken out in the same manner, care being taken not to use any force or the tip may be broken. If the wedges fit tight, or, as is sometimes the case, have been glued in by an inexperienced repairer, it is better to cut them out with a small chisel or violin-maker's knife, and fit new ones rather than run the risk of damaging a good stick.

Having seen that the wedges are in good

condition and fit to go back in their places, or new ones made, take the knot of new hair in hand. It will have a knob of sealing wax at the tied end, and this will be found too large, so most of the wax must be chipped away. Then hold the end in the flame of a candle or other convenient light, and melt the remaining wax into a small, tight knob, small enough to fit comfortably in the recess in the tip of the stick ; bend the end of the knot of hair so that the knob turns under and well down in the bottom of the recess, and fit in the wedge. If this is properly shaped, the tip end will be quite safe.

The stick should then be fixed in a vice, between rubber or cork pads to prevent marking. Comb the hair out with a fine tooth comb, and then well soap it, using ordinary yellow soap and lukewarm water. When well lathered, grip the hair at the tip of the bow between the thumb and forefinger of each hand alternately, and draw them down the full length of the hair. This separates the hair and straightens it out. When there are no signs of any crossing of the hairs, insert the fine comb close up to the tip end and draw it right down the hair ; this brings it together again ready for tying off. Slip the nut on the stick as far in towards the middle as the slot in the stick will allow, and tie off the hair about $\frac{1}{4}$ in. behind the back of the recess in the nut. This allows for turning the hair under the wedge. Waxed thread should be used for tying, and the surplus hair should be cut off with sharp scissors, not too near the thread. The ends of the hair are then singed, dipped in powdered resin, and singed again, until a hard, strong knob is the result, care being taken not to burn the thread. Slip the silver ferrule on the hair, first ascertaining which is the right way on, and then fit the hair snugly in the nut and fix the wedge.

The nut can now be fitted to the stick, and the tightening screw inserted and partially screwed up, when the hair will gradually straighten out, which process can be helped by a little judicious pulling at the hair with the left hand, holding the stick near the nut with the right. Bear in mind that the hair must be perfectly straight and even before the slide and ferrule are fitted. The hair should remain fast in the nut with the wedge only, otherwise it is not a good job. The slide and ferrule are only for ornament and finish ; the old violin bows had none, and, indeed, a good many double-bass bows are in use at the present time without them.

When the hair is evenly stretched, slip in the slide, and fit on the ferrule. Then insert the thin flat wedge under the hair. Take care to spread the hair out to the fullest possible width, and see that it is evenly distributed across. The hair should then be well washed to get rid of the soap, wiped all over with a clean cloth—hair as well as stick—and set over a mantelpiece or other place to dry.

Methylated spirit is sometimes recommended to cleanse the hair of any grease, but is not necessary if the washing is thorough.

The bow should be looked to from time to time, as the hair contracts with drying, and the screw should be slackened as often as necessary. No glue or adhesive is required for any of the blocks or wedges, if they are properly shaped.

A Garden Frame Made in Sections

No garden is complete without a cold frame, but many people find this useful accessory more or less a nuisance in the summer months because of the valuable space it occupies.

The Base. — The design given by Fig. 1 overcomes this difficulty. The frame is easily and rapidly constructed, taken apart in its five sections, and as readily re-made. The sections are flat and allow of being packed away neatly and in the least possible space.

The inside dimensions are, as shown in Fig. 2, 4 ft. long by 2 ft. 3 in. wide. Garden frames have to withstand very rough use, and for this reason the wood should not be less than 1¼ in. thick. The vertical battens, 3 in. by 1 in., are nailed securely on the outside of the frame so as not to obstruct the inside (see Fig. 2). The section represented by Fig. 3 shows that the base portion is arranged to be 1 ft. 6 in. at back and 9 in. in front.

The back and front are the first to

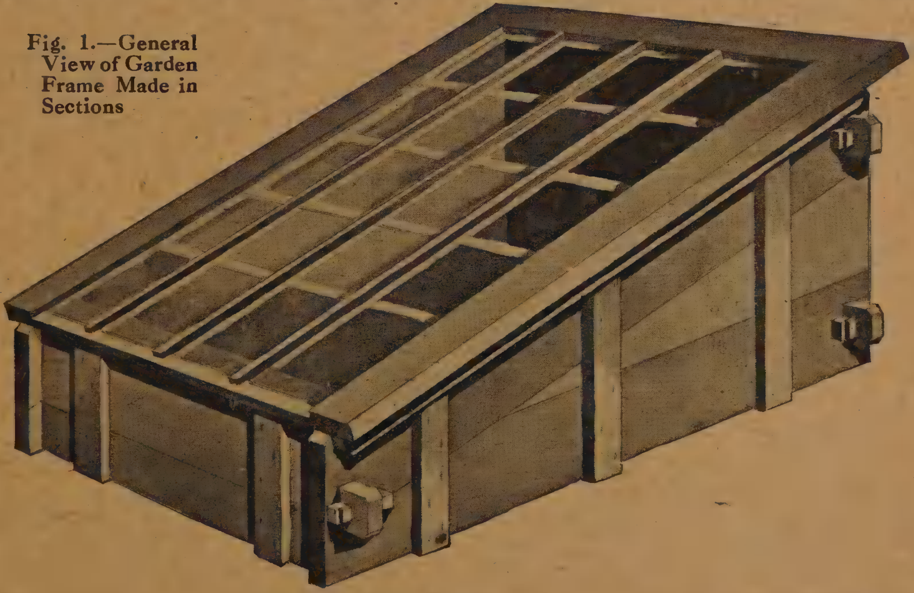


Fig. 1.—General View of Garden Frame Made in Sections

prepare (see Figs. 4 and 6). For the front, one board 6 in. wide and 2 ft. 11 in. long and one 3 in. wide and 2 ft. 3 in. long will be necessary, and two 9-in. lengths of 3-in. by 1-in. batten. On the 2-ft. 11-in. board is set out the tusk, as it is called. This is a simple matter, and if the worker closely follows Figs. 4 and 6, and the diagram of the joint (Fig. 5) no difficulty should present itself. The method is to measure to the centre of the length of the board, and, with a set-square and marking knife, to mark a line at right angles to the sides. Take 1 ft. 1½ in. (half 2 ft. 3 in.) on each side of this line and mark two further lines at the points so found to indicate the inside extent of the frame. Mark on the wood the thickness of the sloping sides, namely, 1¼ in. (see Fig. 2), thus leaving 2½ in. on each end for the projection of the tusk beyond the outside extent of the base. Now mark 2½ in. up from the intended bottom of the board and extend the line with the set-square to the line corresponding to the inside of the frame. With a pencil, mark in the inside line of the frame until it intersects the 2½-in. line just obtained, thus indicating clearly the positions of the saw cuts. Repeat on the other end of the board. Mark the exact position of the 1-in. by 1-in. hole through the 1¼-in. thickness of the wood, through which the wedges will pass; do this by drawing the horizontal centre line of the 2½-in. tusk and measuring ½ in. above and below it to get the height, and for the width 1 in. from the line indicating the outside of the frame. It is advisable to mark the positions of the battens, which, as shown in Fig. 4, are fixed 3 in. from the inside lines. For the setting out of the back, a similar method is followed, but the tusks are cut in the centre of the width of the top and bottom 6-in. boards; the timber for the back comprises two boards 2 ft. 11 in. long, one board 2 ft. 3 in. long, and two battens each 1 ft. 6 in. long.

It is wise to cut and chisel out the 1-in. by 1-in. holes to take the wedges first, and then to proceed to make the saw cuts.

The sides of the frame (see Fig. 7) call for more consideration and care in setting out. The material for the two sides will be two boards 6 in. wide and 4 ft. 6 in. long (for the bottom), one board 3 ft. long and 6 in. wide cut diagonally to form the two wedge-shaped pieces, and two boards 4 ft. 8 in. long and 6 in. wide to provide the top sloping boards (the extra 2 in. is to allow for the angle at which the boards are placed). For the six battens a 6-ft. length of 3-in. by 1-in. stuff will be sufficient. To ascertain the angle at which to cut the front end of each bottom board, place it on an even surface together with another board of the same thickness, which should abut its top edge. Mark 3 in. up from the base edge of the bottom board in front and 12 in. up from the base edge at the back; this 12-in. mark will, of course, come upon the second piece of wood. Join the points and the angle of saw cut will be marked (see Fig. 7). To batten these sides up after cutting them out, adjust accurately the back edges, and nail the wedge-shaped pieces to the bottom boards through the thin end, as shown in the sectional view, Fig. 3. See that the slopes of the two boards are continuous, and then place the top sloping boards in position and securely attach the battens with nails or 1¾-in. No. 7 screws.

The battens stop 1½ in. short of the top edge of the section, to allow the guides on the top light to pass.

The holes for the tusks on the front and back sections have now to be cut. These are 2½ in. long by 1¼ in. wide, and are placed 1½ in. from the outside edges of the side sections. Their exact height is best obtained by placing them, together with the back and front portions, on a flat, even surface, and then marking with a knife. They are pierced by first boring with a 1¼-in. centre-bit run in from both sides and finished neatly and smoothly with a chisel. The double or folding wedges must be of hardwood (teak, oak, or elm), and are cut from an odd piece of 1-in. stuff, a piece 5 in. long and 6 in. wide being sufficient to cut the six pair. Single wedges are disastrous in use, since

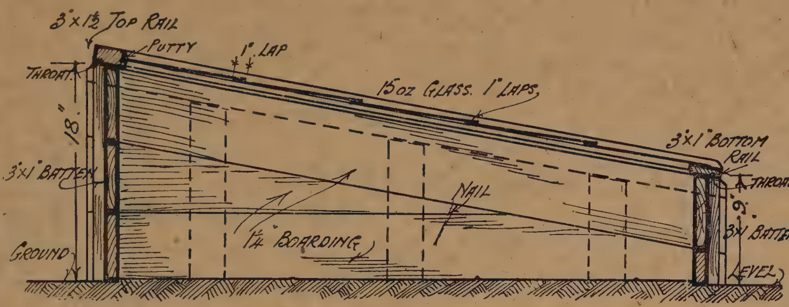


Fig. 3.—Longitudinal Section Through Garden Frame

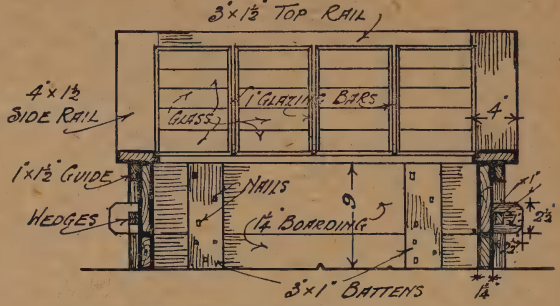


Fig. 4.—Front Elevation of Garden Frame

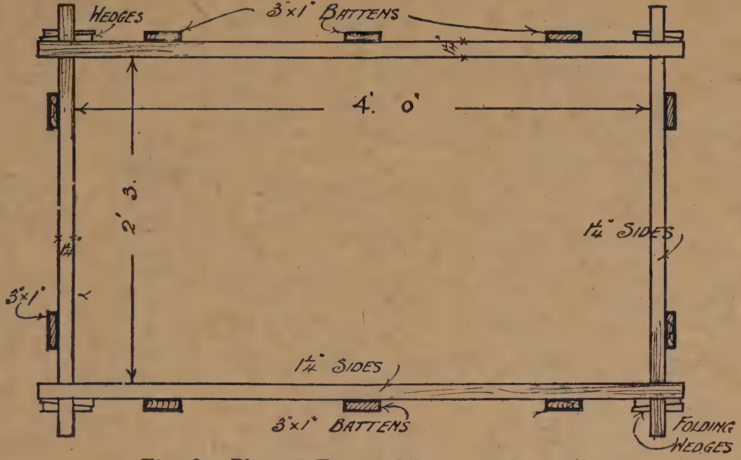


Fig. 2.—Plan of Frame, Without Glazed Top

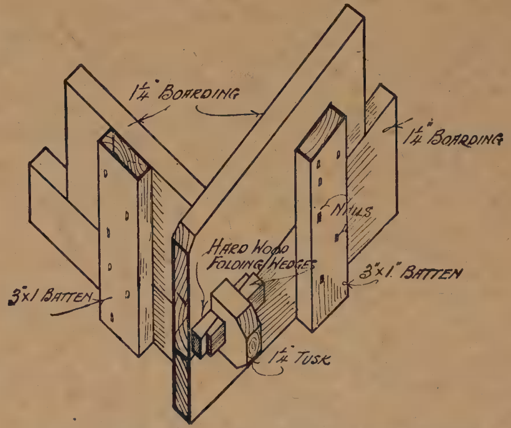


Fig. 5.—Wedged Tusk Tenon Joint Between Side and End

they cannot give equal pressure on the tusk and the boards.

The four sections forming the base of the frame can now be placed together and secured with the wedges. The top edges of the front and back sections must be planed, when in position, to the slope of the sides.

In Fig. 8 an alternative form of angle fixing is given. It consists of a 1-in. strip of stout hoop-iron formed in a stirrup bolted through the thickness of the front and back sections with ¼-in. bolts, this replacing the wooden tusks already described. Wedges are driven vertically through the 1-in. projecting portion of the stirrups, this making a strong piece of work, but care must be given to see that the angles of the stirrups are square before the wedges are driven in.

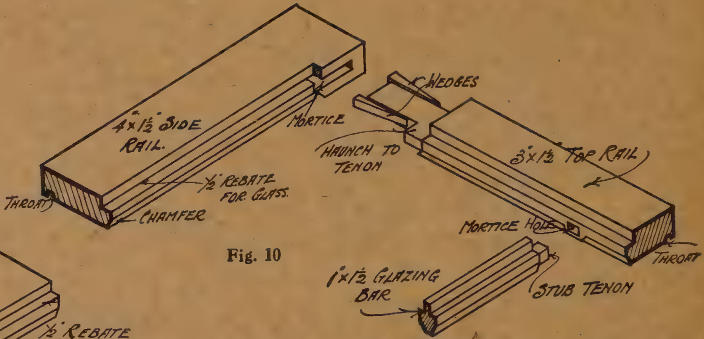


Fig. 10

Fig. 10.—Joint of Side of Light with the Top Rail

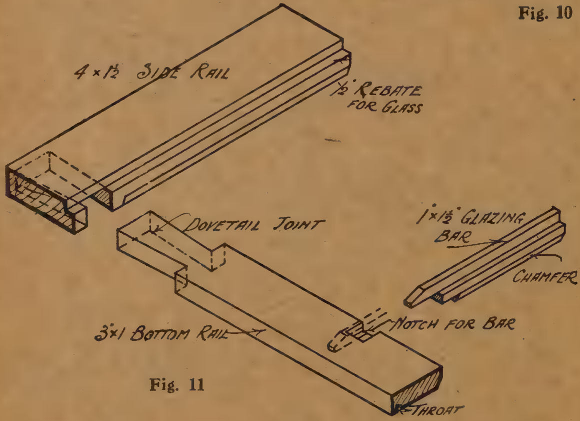


Fig. 11

Fig. 11.—Joint of Bottom Rail of Light with the Side

The Glazed Top.—Fig. 9 is a plan of the light, which is constructed of side rails 4 in. by 1½ in., top rail 3 in. by 1½ in., and bottom rail 3 in. by 1 in. The light is divided into four spaces by three 1-in. by 1½-in. chamfered, rebated glazing bars, which are bought ready-made and very cheaply. The joint of the side with the top rail, see Fig. 10, is an ordinary mortise-and-tenon joint wedged up, there being a 1-in. haunch to the tenon as shown. Before painting and wedging up the tenons, a ½-in. rebate should be run in the top inside edge, stopping it 2½ in. from the top end of the side rail; and a stop chamfer is made on the under inside edge ½ in. deep and ¼ in. on the under surface. A ¼-in. throat (see Fig. 10) is made on the outside under surface ½ in. from the outside edge to throw off the water. Fig. 10 shows the glazing bar stub tenoned into the top rail, this being the correct method of jointing. The glazing bars should be accurately spaced so as to take the same width of glass for the whole series. The joint at the bottom rail with the side is shown in Fig. 11, and consists of dovetailing the 1-in. thickness of the bottom rail into the side rail, and then, when both joints are so prepared, securing them by stoutly screwing or bolting them with ¼-in. bolts to one another. This joint should receive special care to ensure its fitting tightly and truly. The intersection of the base of the glazing bar is shown in this figure also, and as will be seen, consists of notching 1 in. by ½ in. of the bar into the bottom rail, providing for the rebated portion to continue to within ½ in. of the

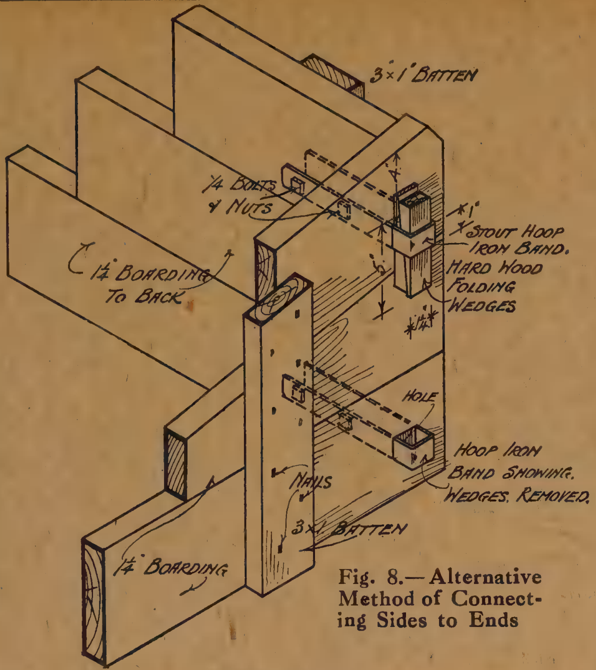


Fig. 8.—Alternative Method of Connecting Sides to Ends

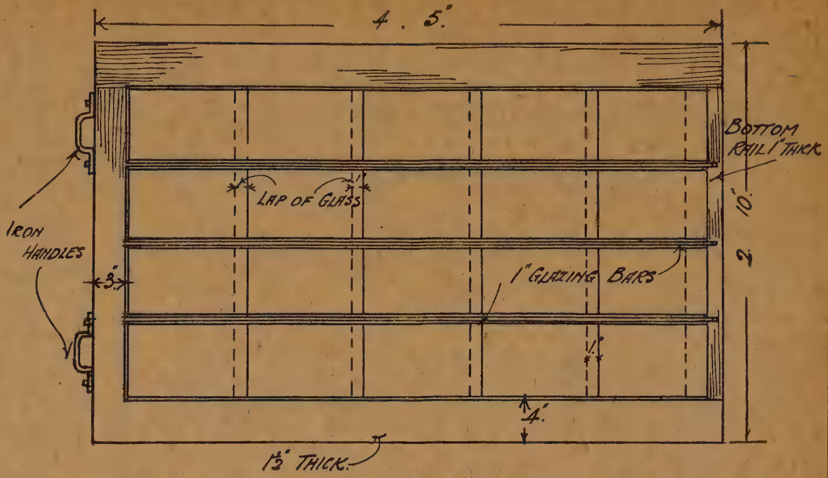


Fig. 9.—Plan of Glazed Light

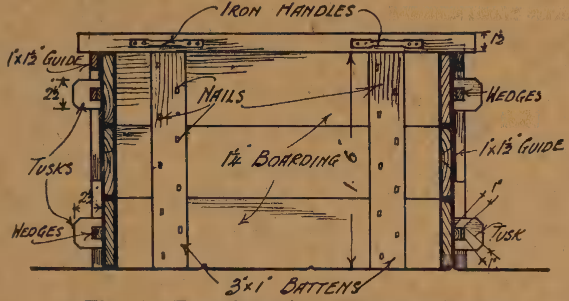


Fig. 6.—End Elevation of Garden Frame

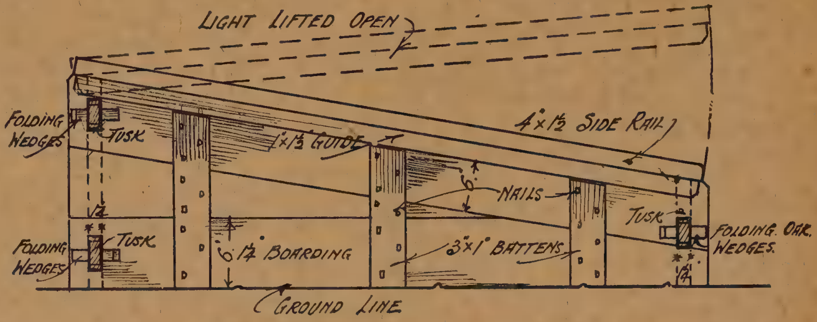


Fig. 7.—Side Elevation of Garden Frame

front, through which portion the bar is nailed to the bottom member. A $\frac{1}{4}$-in. throat and chamfer is worked (see Fig. 11) on the bottom rail.

The 1-in. by $1\frac{1}{2}$-in. guides, shown in Figs. 4 and 7, are fixed by bolting or strongly screwing to the under-side of the side rails. They keep the light in position over the base. The light projects 1 in. all round on the outside and $\frac{3}{4}$ in. on the inside.

A pair of iron handles is fixed at the back to pull the light up for ventilating purposes. The glazing should be in 21-oz. horticultural glass in five widths, and lapped 1 in. as shown, the slope indicated being steep enough not to allow the rain water to creep back by capillary attraction between the sheets of glass. The glass should be back puttied and sprigged in.

Painting.—All the woodwork should be knotted, stopped, primed and painted, three coats at least, and preferably four coats, and the bottom 6 in. board of the base portion might be treated with tar, creosote, Solignum, or other wood preservative to prevent decay.

Electric Pole Finders

It is often of importance to be able to decide which of the leads from a battery is negative and which positive. Pole-finding solutions and papers may be used for the purpose.

Solutions are as follows: In 1 oz. of distilled water dissolve 2 or 3 grains of sodium sulphate, and add a few drops of a 1 per cent. solution of phenol phthalein dissolved in alcohol. Normally this solution is colourless. On passing current through the solution a reddish-purple colour will be observed at the electrode connected to the negative power lead.

Another solution: Instead of the phenol phthalein, add to the sodium sulphate solution one drop of a 1 per cent. solution of methyl orange dissolved in alcohol. Normally the solution is of a yellow colour in neutral or alkaline solutions, and red in acid solutions. Therefore, on passing current through the solution, the presence of the acid at the positive electrode is indicated by a red colour at the electrode connected to the positive power lead.

The above solutions are very sensitive, and the first of them, being colourless normally, is to be preferred. There should be no difficulty in getting either solution made up by an analytical chemist. The electrodes (plates immersed in the liquid and connected to the battery wires or terminals) may be of copper, 1 in. apart

Pole-finding paper, made as below, needs to be moistened and touched with the ends of the two wires, which should be about $\frac{1}{4}$ in. apart, the positive pole producing a brown spot. Mix 1 oz. of best starch with distilled water to form a thick creamy paste and stir in boiling water until the starch becomes translucent. Add the greater part of a pint of water in which has been dissolved $\frac{1}{2}$ oz. of potassium iodide and 1 oz. of potassium nitrate. When cool, immerse in it pieces of white filter paper and dry in the dark.

To find the poles of any electrical circuit from 2 volts up to 500 volts, take a potato and remove a portion of the skin, then insert the ends of the two copper-wire leads into the potato, a short distance apart for 2 volts, and farther apart for higher voltage, in order to increase the resistance. It will then be found that the positive lead will turn the potato green, the negative lead making no mark whatever. The time taken to obtain the result is about one minute for low voltage, and less than that for high voltage. The action is really that the moisture in the potato acts as an electrolyte and decomposes the copper.

Air-gas: What It Is, and How to Make the Plant

THE lighting agent that is now known as air-gas is a mixture of petrol vapour and ordinary atmospheric air, the proportion of spirit vapour being quite small compared with the air; 2 per cent., or even less, of the vapour to about 98 per cent. of air is the usual proportion.

Air-gas, although it bears several names, such as safety-gas, non-explosive gas, petrol-gas, etc., must not be confused with the system of petrol lighting in which the petrol is conveyed in an unchanged liquid state by small tubes direct to the burners.

There is no liquid petrol in the pipes of an air-gas installation (or should not be), the mixture of spirit vapour and air being of quite a gaseous nature when properly made.

Air-gas is not a true gas, for it is only an intimate mixture (a "mechanical mixture" not a "chemical combination") of vapour and air, and it is often thought that such a mixture must separate and be unreliable if subjected to changes of temperature or to certain common conditions that are recognized as causing separation. Instead of this, the two component parts remain associated in quite a satisfactory way, sufficient for all the purposes that a gas-making plant for a country house or village is expected to fulfil. Of course, this is only the case when the gas is properly made, and there is no disguising the fact that a bad mixture is quite possible, in which the component parts readily separate or in which changes occur that cause liquid petrol to appear in the gas services. This, however, is not the case with the majority of the air-gas plants that are now on the market, and should not occur in any air-gas plant.

Petrol (practically identical with gasolene, petroleum naphtha, benzine, and benzoline) is distilled from petroleum chemically; it is a mixture of a number of hydrocarbons, the specific gravity being from about ·68 to ·73. For air-gas purposes, a specific gravity of about ·685 (say 6 lb. 14 oz. per gallon, net) is desirable. Petrol is very volatile, the lighter portions evaporating first.

Making Air-gas.—Air-gas or safety-gas is made by causing air (that is, ordinary atmospheric air) to become intimately associated with petrol. This is done by passing the air over or through petrol, until the petrol is evaporated and the air becomes charged with petrol vapour. The action is a drying process pure and simple, and the air readily absorbs such a volatile fluid, the mixing being done without the aid of heat or pressure or any complex mechanical process; when the air is thus "greased," as it has been called, it is combustible at suitable burners.

Evaporation of the spirit is produced in several ways. As already stated, air may simply pass over the top surface of the spirit, which is placed in a closed shallow vessel, and though this is quite sufficient for making air-gas, it is not a plan that is usually adopted with generators of fair size, because the spirit, giving off its lighter vapours first, becomes heavier and less evaporative as its lighter parts are used.

This is one of the difficulties that are experienced in evaporating petroleum spirit, there being always a pronounced tendency of the spirit to separate into grades. It is easily possible, therefore, to have a carburettor (the chamber or vessel in which the air and petrol become associated) which, receiving spirit at, say, ·685 specific gravity, will, after a moderate period of use, be found to contain spirit of ·710 specific gravity. This would mean probably a brilliant light at first, but gradually decreasing in brightness as the spirit increases in specific gravity. One must always remember that in making air-gas the spirit must be of a certain specific gravity, which must be maintained, if possible, as long as the apparatus is being used. A difference of ·10 specific gravity is permissible (say from ·685 to ·695), but more than this gives a sufficiently wide difference in results to cause complaint.

Owing to the fact that the spirit must be used up (dried up by the passing of air) as uniformly as possible, an arrangement must be made by which the air can have intimate contact with the spirit in a manner that does not admit of much or of any separation in the spirit; and of the various systems that are used in order to produce this result, two may be mentioned that are known to be effective. In one method the spirit is pumped into the carburretting (air and spirit mixing) chamber, where an atomiser reduces the liquid to an exceedingly fine spray that is almost a vapour itself, which the air absorbs uniformly. In the other system the petrol is delivered in drops on to a revolving wire-gauze screen through which the air current must pass, and as the air dries all the moisture from the screen, separation of the spirit may not be expected to occur.

Keeping Qualities of Air-gas.—As regards the permanency of this gaseous mixture, it will be readily seen that if under ordinary conditions the petrol vapour had a tendency to condense and leave the air free of or with insufficient spirit vapour, then air-gas would never have reached the practical stage of an illuminating gas. Water vapour mixed with air is known to condense, and this fact has led many persons to suppose that spirit vapour would act in the same manner. But spirit vapour does not condense under ordinary conditions, as is shown by some tests that are described below. In one test air-gas was delivered through several hundred feet of coiled pipe that was covered with ice; no failure occurred, for the gas burnt properly after passing through the pipe, and no liquid (condensed) petrol was found in the pipe. In another test, made by the writer, a 50-ft. gasholder in a factory yard was filled with air-gas that was not specially prepared as regards richness or other quality, and this gasholder was left untouched (not even examined) from Friday to Wednesday, over the Christmas holidays. During this period the water of the holder-seal was frozen. On the following day a thaw occurred, and after the six days' exposure to cold the gas could still be burned and gave fair results, though it had apparently lost something in quality. These tests answer a question often asked, "Will the gas be good for use at night if it is made in the daytime?" In other words, will the gas keep for eight hours?

Two reasons may be given for this keeping quality of the air and petrol-vapour mixture (air-gas). The first is that the union of air and petrol vapour is more intimate, and the difficulty of afterwards separating them is greater than in the case of air and water vapour. Secondly, air-gas, if properly made, leaves the carburetting chamber at a much lower temperature than the pipes or the gasholder into which the gas flows. Assuming that a reduction in temperature is the general cause of disunion between air and vapour, reduction can never occur if the gas-making chamber is always the coldest part of the installation. The reason why the carburettor is cold is that the process of evaporation is always accompanied by a reduction in temperature, so that the air and the spirit being both of them at normal temperature, union by evaporation produces a still colder gas. Experience has often proved that when the thermometer shows the air to be about 38° F., the carburettor will be coated with hoar-frost or thin ice, showing that its interior is below freezing point (32° F.). The outside coating of ice is produced by the water vapour in the outside air condensing on the cold exterior surface of the carburettor; such condensation occurs on any metallic surface that is colder than the surrounding air. The fall in temperature has no effect, good or bad, on the gas plant, and is only mentioned to prove that the process going on inside the carburettor is one that brings about a considerable reduction in temperature.

The air undergoes no chemical change as the result of the coldness that accompanies the evaporation of the spirit and the carburetting of the air; it remains ordinary atmospheric air, plus a very little petrol in a state of vapour. A trifling change that sometimes occurs in the air is the loss of some of its water vapour, because air cannot be made very cold without causing condensation of some of its water vapour. Air readily absorbs water, and may be said to carry always a certain amount proportionate to its temperature. If air is heated it will at once absorb any available moisture, and if cooled it at once parts with moisture. There must therefore be some condensation of water vapour inside the carburettor where the air becomes cold during the evaporation of the spirit, and provision is accordingly made for drawing off the water. This usually means drawing off some petrol also, but as water is heavier than petrol, it can always be found at the bottom of any vessel or chamber containing the two. The condensed water difficulty, however, is not a serious one. In summer time it is scarcely noticeable, but in winter, with wet westerly winds, mist and fog, the air may carry an unusual proportion of water vapour. The writer has not, so far as his observation extends, known the gas to be prejudicially affected, provided the water can pass away and not be re-delivered to the gas-making chamber with the new petrol. Water, if mixed with petrol, can be separated by pouring the mixture through a funnel having wire gauge 60 × 60 = 3600 mesh (3,600 openings) to the square inch. Petrol will pass through this, but the petrolised water will not.

Air-gas is Non-poisonous.—The most noticeable qualities of air-gas are that it is non-poisonous, non-explosive, and costs very little. The non-poisonous character of the mixture is shown in several ways; for example, in rooms where dry-cleaning is carried on (in which petrol is largely employed) the air becomes highly charged with petrol vapour, probably more highly than the percentage that goes to make air-gas; in many retail paraffin stores, where the oil is handled carelessly, the air becomes charged with the vapour of petroleum spirit, and is breathed without hurt; while those who experiment with air-gas, or have the testing of air-gas machines, breathe the gas pure and in every degree of dilution without discomfort or ill-effect. Petrol vapour by itself is not poisonous, and air is, of course, necessary to life; and by a rough computation a 10-ft. room, full of air-gas (1,000 cub. ft.), would not have in it 20 ft. of petrol vapour.

Air-gas is Non-explosive.—Although this gas has been in common use for several years, no instance of an explosion has been known, so far as the writer is aware. When acetylene came into use its explosive character soon became apparent, and several lives were lost; and it will no doubt always be dangerous, like coal-gas, so long as people are careless; but, for all that, acetylene is a safe gas, and nothing can be said to the contrary if those who make and use it will take reasonable precautions. With air-gas, however, it seems that precautions are scarcely necessary, for it cannot be supposed that no one has been guilty of carelessness in its use. Petrol itself must certainly be treated with care; but probably the use of petrol in the motor-car has educated people into handling it carefully.

There now comes the question of the explosiveness of a mixture of petroleum spirit and air, which is usually stated to range from 2·2 to 4·5 per cent. of spirit vapour (without compression) to 97·8 and 95·5 per cent. of air. Consequently the majority of makers of air-gas plants arrange that the gas should be made as "poor" as possible, say 1·4 of vapour to 98·6 of air; but if a richer gas is made say 1·9 of vapour to 98·1 of air (which is nearly 40 per cent. richer) it is still within the limits. Even supposing that the gas had, say 3 per cent. of vapour a leakage lasting for a long time would be required in order to make an explosive or even an inflammable mixture in a moderate-sized room; therefore under the worst conditions, air-gas is far safer than coal-gas, which has a range of explosiveness about ten times as great. Air-gas, as usually made, is non-explosive; but supposing that the gear that controls the quality of the gas were to fail and permit rich gas to be made, its escape into a room in fairly large volume would not be harmful, as the air of the room would dilute it to a non-explosive mixture.

Costs Compared.—An authority has worked out the following comparison :

Source of light.	*Each unit of light.*	*Cost per* 1,000 *candle-hours.*
Coal-gas ; incandescent C burner (ordinary inexpensive make) consuming 4 ft. of gas per hour. Gas at 5s. per 1,000 ft.	60 c.-p.	3·9d.
Coal-gas ; self-luminous flat flame, consuming 6 ft. per hour. Gas at 5s.	16 c.-p.	22·5d.
Acetylene ; incandescent mantle burner consuming 0·5 ft. per hour. Carbide at 20s. per cwt.	50 c.-p.	6·8d.
Acetylene ; self-luminous flame consuming 0·7 ft. per hour. Carbide at 20s. per cwt.	27 c.-p.	12·2d.
Air-gas, with petrol at 2s. 6d. per gal.	from 75 to 100 c.-p.	3·5d.

In lighting small rooms, or any rooms in a residence, the comparisons in the table do not work out so favourably to air-gas as the figures appear to show. Thus. four 30-c.-p. burners will usually light a room 18 ft. by 16 ft. as satisfactorily as two 75-c.-p. burners, because four low-power burners properly distanced diffuse the light to all parts of a room quite as well as two burners of higher aggregate power. On the other hand where high-power lights are required. they are often superior to a large number of low-power lights. Over a billiard table, for instance, six 75-c.-p. burners would do rather better than six groups of three 25-c.-p. burners; while in halls and for industrial purposes the high-power burner may serve best in most instances.

A passing reference may be made to the difficulty that may be experienced by anyone inquiring into the cost of air-gas, when he finds that one maker claims to produce much more gas from a gallon of petrol than another maker. The various machines on the market certainly do produce varying volumes of gas per unit of petrol; but one must not infer from this that the *light* from any one machine costs less than from another. It is the petrol that makes the light, and the varying volume of gas is made up of a varying quantity of air. What is known as a "poor" gas (the word "poor" not being used in any detrimental sense) has a large volume of air, say, 98·6 of air to 1·4 of vapour, while a (comparatively) rich gas may have, say, 1·9 of vapour, or nearly 40 per cent. more, so that the volume of gas produced per gallon of petrol will vary by about the same percentage. But the ultimate cost comes out the same, because with the rich gas a less volume has to be burned for a given light than is required of the poor gas, and for a given service the outlay in petrol per month or per year will be found to be the same. Whilst, probably, no one person can have tried all the makes of air-gas in order to settle this point, there is a feeling of certainty that all makes require the same amount of petrol for a given degree of light or heat. The volume of gas is very misleading, and must not be considered as a standard in any sense. The true standard (with any illuminant) is the cost of the light per hundred or per thousand candle-hours. A candle-hour is a light of one candle-power for one hour; fifty candle-hours, for example, is the light from a 50-c.-p. or two 25-c.-p. burners for one hour, or one 25-c.-p. burner for two hours, and so on. Realising that it is the petrol that makes the light, it will be found that 1 gal. of petrol made into air-gas will (or should) afford a light of 9,000 candle-hours in practice. Theoretically, it will do more, but on the user's own premises calculated figures are not usually borne out. This figure will stand whether the machine makes little or much gas per gallon of petrol, for, as stated, the gallon of petrol will produce a definite quantity of petrol vapour and no more; but this vapour may have air added to a greatly varying extent by different makes of machines.

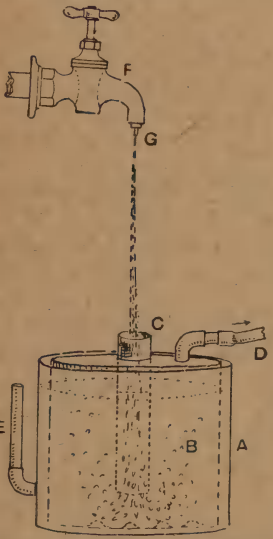


Fig. 1.—Aspirator for Small Experimental Plant

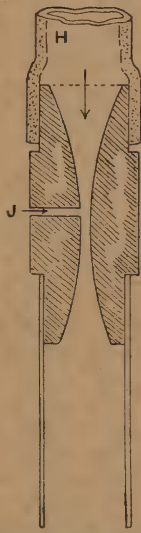


Fig. 2—Chapman's Aspirator

METHODS OF PRODUCING AIR-GASES

In making air-gas the essential condition is a continuous current of air passing through the carburetting chamber (in which the air meets the petrol and an inflammable mixture is produced). As a burner may consume anything from 4 cub. ft. of gas upwards per hour, it will be seen that air must be furnished in fair volume, and as only quite small gas holders are used (on account of the expense) the air supply must be continuous. This important detail has been the chief difficulty in the way of the amateur making an experimental apparatus, as the ordinary type of air propeller is not only expensive or difficult to make, but requires a motor of some kind to drive it. For the purpose of the experimenter, illustrations are here given of two forms of aspirator that may be easily made, and which will supply air in moderate volume for two or three lights; and, later in the chapter, a home-made water-driven plant will be described. Fig. 1 shows a device which has been found to work successfully, while Fig. 2 shows a Chapman aspirator fixed to the upper part of tanks that are similar to those used in Fig. 1. The Chapman aspirator is a device that is largely used for either extracting or delivering air (in moderate volume).

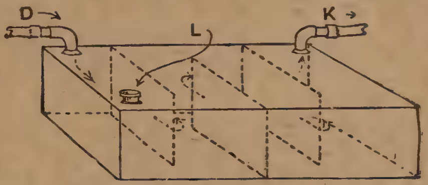


Fig. 3.—Surface Carburettor

Fig. 1 shows an outer pan A of 6 in. diameter with an open top; inside this is a 5-in. pan or tin B, inverted, the lower edges being roughly serrated so that water can pass beneath either way. The inner pan must be soldered in, or weighted, so as to keep it from rising. In the centre of the inner pan is soldered a tube C, 1 in. in diameter, open at the top and bottom and reaching down to within about $1\frac{1}{4}$ in. of the bottom. The height of the pan is 5 in.

From the top of the inner tin a pipe D

conveys away the air. The overflow E to the outer tin is arranged as a stand pipe and elbow, so that by turning the pipe down the level of the water in the pans can be lowered. This apparatus, when used for delivering air, is placed under a water tap F (about 2 ft. below it), in the nose of which is fitted a plug or cork through which passes a fine metal or glass tube G. The fine stream of water that falls into the tube C carries air with it, which is forced down to the bottom of the tube and rises outside the tube in the inner pan. From the top of the inner pan the air passes away by the pipe D.

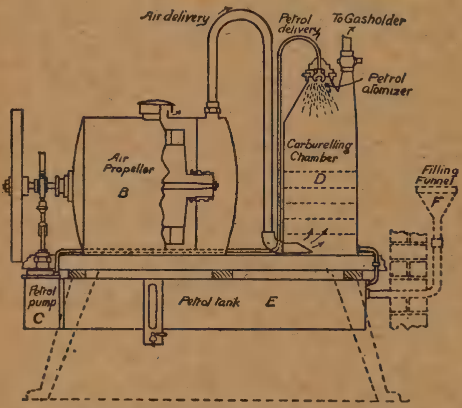


Fig. 4.—The Praed Air-gas Plant

The aspirator (Fig. 2) is connected at its upper end directly to a tap (without any plug in the nose of the tap) by a piece of indiarubber tube, while its lower end might terminate in the top of the inner pan of Fig. 1. This aspirator should be made of brass, turned in a lathe; the shape of the contracted passage through the tube has much to do with its efficacy; J is the air inlet. The aspirator is based on the principle of the Gifford injector.

The Carburetting Chamber.—For making the gas, a carburetting chamber is necessary, through which the air must pass in order to be converted to air-gas. For experimental purposes a surface carburettor will serve, and Fig. 3 shows its internal construction. A tin box 12 in. by 8 in. by 3 in. high should be large enough, and it should have four divisions in it extending nearly across, alternately, as shown.

The fault of this form of carburettor for practical purposes is that the lighter and more evaporative part of the spirit is taken first, while the remainder becomes gradually heavier and less effective in carburetting the air; the result is a gas of gradually decreasing lighting power. If the user desires to regulate the quality of the gas (that is, to reduce its richness when first starting), a by-pass pipe can be carried from the air-inlet D to the gas outlet K, outside the box, so as to supply additional untreated air to the gas that is made. This by-pass pipe should be provided with a tap so as to regulate the amount of air passing through. L is the filling-opening.

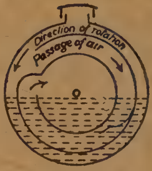


Fig. 5.—Principle of Air-propeller

All the different methods or systems employed in the various air-gas plants on the market cannot be described here, but in all of them the one result that is aimed at is to pass into and through a chamber a sufficient and constant current of air, which before it leaves the chamber will be properly petrolised so as to make it combustible. Some plants are provided with automatic controls, others have none. In the majority of cases the motive power is provided by a small hot-air engine, others are driven by a falling weight (with a cord passing round a revolving drum), while others rely on a water-motor. Of course, a water-motor can only be used when there is a good supply of water under a fair pressure, and this is not often the case in country houses. The water-motor, however, is a satisfactory source of power when it can be used.

A Typical Air-gas Plant.—Of the many air-gas plants that are on the market, one (Praed's patent), which is shown in Fig. 4, has been chosen for illustration because it is easily understood. On the extreme left is a driving wheel, which may be operated by a 1-in. leather belt from a hot-air or water-motor. If a weight-drive were used, a horizontal drum with a wire cord wound round it would take the place of the wheel. When the driving wheel is running it operates the petrol pump C, which draws petrol from the tank E and delivers it into the carburetting (gas-making) chamber D, and also operates the air propeller B, which is responsible for delivering the needed supply of air to the same chamber. The petrol is delivered through a $\frac{3}{16}$ in. copper tube to the top of the carburettor, inside which is fitted a small two-armed device that causes the petrol to be atomised into fine particles like a cloud. As the air enters the bottom of the carburettor and can only find an outlet at the top, it must of necessity pass through this cloud of petrol spray which produces the required mixture in a very effectual manner.

The air propeller in this particular plant is a modification of the Wirtz pump, which is a positive acting appliance and silent in its working, but it occupies more space than a blower of the Root's type. The speed of the propeller is comparatively slow, about thirty revolutions per minute being a maximum. The action of the propeller can be seen in Fig. 5, which shows one of the coils, of which there are four. The openings of the coils are at different points or levels so as to avoid a dead-point. The air enters the outer casing or drum freely through the loose-fitting cap, and as the opening of a coil comes up, air enters the coil. When the coil dips beneath the liquid seal, the air that is imprisoned in the coil can only escape by entering the inside space of the inner drum. From this inner space the air passes through a 5-in. hollow bearing into a separate chamber (see Fig. 4), and thence, by a looped pipe, to the carburettor D. For the liquid seal in the propeller paraffin is generally used, not because this light oil is necessary, but because it does not freeze, nor does it cause iron to rust.

Choice of Motive Power for Air Propulsion.—A cheap air-gas plant would be a boon to many, but as yet no one has solved the problem how to get air propulsion cheaply. By adopting a falling weight as the driving force, the power costs nothing afterwards, but the installation is expensive, while water power, which is less expensive for the mechanism, is usually more expensive afterwards (except to the few who have a good supply of water at good pressure without having to pay much for it). About the least volume of air used is 4 ft. per burner per hour, so that for a small installation of five burners there requires to be 20 cub. ft. of air passed through the apparatus per hour. To do this an air propeller is needed, and it is the power to drive the propeller that proves a difficulty as regards cheapness. The hot-air engine is commonly used, but a small one of $\frac{1}{40}$ horse-power costs about £4. The weight-drive, if properly fitted up, would cost as much, while a water-motor can be had for about 6s., but it entails a constant expense for water.

THE MAKING OF A WATER-DRIVEN AIR-GAS PLANT DESCRIBED

Capacity of Plant.—The air-gas plant about to be described will feed eight to ten lights, or five lights and a gas cooker; but the capacity can be readily varied by altering the area, and hence the volume of the various bells or drums. The following table will show at a glance the relative area (and, of course, relative volume for a given height of drum) of circles of different diameters:

Diameter.	*Area.*	*Diameter.*	*Area.*
in.	*sq. in.*	*in.*	*sq. in.*
2	3·14	9	63·61
3	7·07	10	78·54
4	12·56	11	95·03
5	19·63	12	113·10
6	28·27	13	132·73
7	38·48	14	153·94
8	50·26	15	176·71

General Arrangement of Plant.—A sectional elevation of the air-gas plant is shown by Fig. 6, while Fig. 7 shows a section of the air-inlet and air-delivery water seals, D and G respectively, which take the place of the mechanical valves usually employed in air-pumping plant.

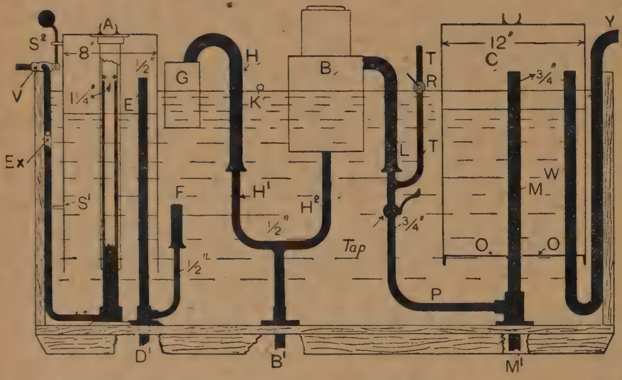


Fig. 6.—General Arrangement of Water-driven Air-gas Plant

In most air-gas plants the air is forced or sucked through the apparatus by either a hot-air engine, which must be kept always running, or by means of weight-operated gear, which latter is heavy and complicated. In the present plant the air-pumping is done by means of water acting on the ram attached to the air-bell or drum A. By means of the two-way valve V (Fig. 6) water is admitted from the water-main to the ram tube, which causes the drum or air-bell A to be lifted up, and air to be sucked into the drum A, by way of the air-inlet or suction box D (see Fig. 7) and pipes F and E. When air-bell A reaches the top of its stroke, the stop S¹, fixed to the lower part of the air-bell, trips over the valve V, cutting off the water and allowing the water in the ram tube to exhaust into the tank. The air-bell now falls by its own weight, and forces its charge of air through pipes E and F, delivery box or water seal G, and pipe H, to the carburettor B, and then through pipes L and M to the gas-bell C. On the air-bell reaching its lower position, the top stop S² fixed to the bell, engages the water valve, and again admits pressure water to the ram. If no gas is being used, the air-bell, when charged, will not be able to descend, and hence the apparatus will stop work until gas is again taken from the gas-bell C.

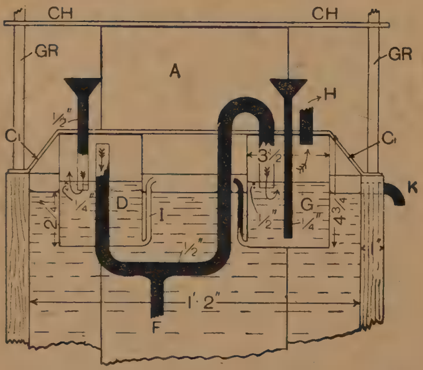


Fig. 7.—Part Side View of Air-gas Plant

The apparatus will work with a pressure of water exceeding 12½ ft. head. If, therefore, the apparatus is at ground level and is fed from a cistern at the top of the house, or from the main, the pressure will be ample. The water supply must be connected direct to the two-way valve. The supply of gas is self-regulated, as the pumping ram only works according to the quantity of gas used. When the air-bell is raised, the work of the ram ceases.

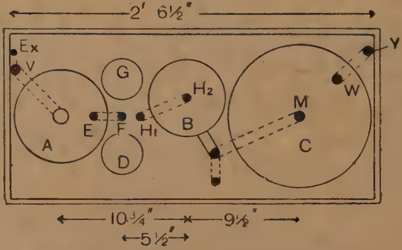


Fig. 8.—Plan of Air-gas Plant

The maker of a plant on the lines here

described found that on the downward stroke of the air-bell water came from the levelling pipe of the inlet chamber, and gas escaped from the funnel. There is no doubt that the water level is depressed in the chambers which have the levelling pipes when the air-bell descends; but this depression should not be great enough to expose the end of the funnel opening. Therefore it is suggested that, should such a trouble occur, the levelling pipes be made of smaller tube, so that water cannot be driven through them fast enough to lower the level so much as it now does. A trial should be made by pinning down the ends so as to reduce the bore through them, and, if necessary, the air-inlet funnel may be dipped a further ¼ in. below water line.

The Water Tank.—As shown in Fig. 6, the whole apparatus is immersed in a water tank, whose inside dimensions are 3 ft. 11 in. by 1 ft. 2 in., with an inside height or depth of 1 ft. 9¼ in. This tank should be well made, using 1-in. wood for the ends and ½-in. or ¾-in. for the bottom and sides, all parts being carefully fitted and firmly screwed together. The inside of the tank is lined with stout sheet-zinc, so as to ensure its being watertight, the joints being well lapped over and soldered. Before fixing the tank lining it is advisable to give the tank inside two coats of either "stop-rot" solution or bitumen paint so as to preserve the woodwork.

At any suitable point a waste or drain pipe K (Figs. 6 and 7) must be fixed and soldered to the tank lining, so as to keep a water level of 1 ft. 8 in. in the tank. This waste pipe should not be too small, say at least ½ in., so as not to be readily choked up by dust or dirt. If arranged as shown in Fig. 8, the length of the tank can be reduced to 2 ft. 6½ in.

The Two-way Water Valve.—This is shown diagrammatically in Fig. 9. When the valve is in the position shown at A pressure water is admitted to the ram tube, which is connected to outlet R, the water supply being connected to outlet P. When the valve is turned into position shown in B (Fig. 9), the pressure water supply is cut off and the ram tube connected to the exhaust E. Fixed to the shank of the valve plug is an L-shaped valve pin piece S (Figs. 10 and 11), which is engaged by the two stops S^1 and S^2 fixed to the air-bell A (Fig. 6). Fig. 11 shows a plan view of this L-shaped piece and also the lower stop S^1, while Fig. 12 shows a side view of the stop. In order to ensure that the valve shall not stick in the mid position, a tumbler weight is fitted to the valve, while the stops S^1 and S^2 have also flat springs for the same purpose. Thus once the valve starts to move it is bound to be flicked right over. Referring to Fig. 10, the tumbler weight would be in a position X X when the valve was admitting water to the ram, and in the position Y Y when the ram was connected to the exhaust.

In making the two-way valve, care must be taken to see that the valve plug cuts off the pressure water before opening to the exhaust. Otherwise the pressure water would be able to "blow through" to the exhaust, this resulting in serious waste of water. The top stop S^2 is a duplicate of S^1, but opposite handed, as it engages the valve pin S from the top side.

The valve V (Fig. 6) is firmly fixed to the end of the tank, and the stops on the air-bell A are so set that the top stop strikes the L-shaped valve pin just before the air-bell reaches the lower position; while the bottom stop S^1 trips the valve just before the air-bell reaches the top position.

The Air-bell.—The air-pumping bell A is made of stout zinc and is 8 in. in diameter by 1 ft. 8 in. high, its stroke being about 1 ft. 2 in. to 1 ft. 3 in. When the air-bell is at the highest position, at least 2½ in. to 3 in. must remain under the water. In order to ensure the air-bell rising and falling properly without toppling over, two guide rods or tubes are fixed to the tank sides, and a light cross-head C H (Fig. 7) fixed to the air-bell top has holes drilled in its ends, so that it can slide up and down the guide rods, and thus guide the air-bell and steady it. These guide rods G R are omitted from Fig. 6 so as to avoid confusion, but are clearly shown in Fig. 7. They must be fixed truly vertical and parallel to each other, so that the air-bell can slide freely up and down.

The Pumping Ram.—This consists of two brass tubes, one of which can slide freely over the other. The inner tube is fixed to the tank bottom, and connected by a pipe to the port R (Fig. 9) of the two-way valve V, the tube being, of course, fixed truly vertical and in line with the guide rods or guide tubes G R. The outer tube is fitted to the top of the air-drum, and in order to keep it truly in the centre it is advisable to fit two or three wire stays from the bottom of the tube to the drum sides.

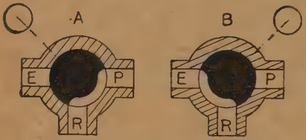


Fig. 9.—Two-way Water Valve

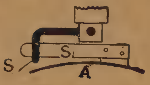


Fig. 11.—Plan of Water Lever and Stop

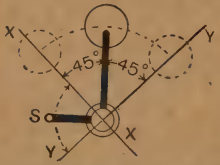


Fig. 10.—Diagram of Water Lever and Stop

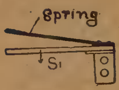


Fig. 12.—Side View of Lower Stop

A pressure of 1 lb. per square inch equals 27·71 in. of water, so that 1 in. of water corresponds to ·578 oz. pressure per square inch. Reckoning 1$\frac{1}{2}$ in. pressure at the burner, and allowing for the weight of the air-bell and the resistance to be overcome in pumping the air through to the carburettor, etc., it is safe to calculate on at least a 3·5-in. (water) pressure in the air-bell, so as to allow a fair margin of power on the ram. The air-bell, being 8 in. in diameter, has an area of roughly 50 sq. in., so that the total force to be exerted by the ram is 50 × 3·5 = say, 180 in. of water, or about 6·5 lb. The ram tube being 1·25 in. in diameter has an area of roughly 1·2 sq. in., so that a water pressure of 5·5 lb. will work the apparatus. This 5·5 lb. corresponds to a head of 5·5 × 27·71 = 152 in., or, say, 12$\frac{1}{2}$ ft., so that the pumping supply can easily be taken from a tank in the roof. The higher the tank the smaller the diameter of the ram and therefore the less the quantity of water taken per stroke.

In order, however, to have a margin of power on the ram to overcome valve friction, etc., it will be as well to allow an extra 5-ft. head on the calculated amount.

The diameter of the air-bell A being 8 in. and its stroke 14 in., for every stroke an approximate 680 cub. in., or ·4 cub. ft., of air are pumped per stroke, allowing, of course, for the volume of the ram tube. And at every stroke is used a tube full of water, 1$\frac{1}{4}$-in. diameter by 14-in. stroke, say 17 cub. in. This may be roughly taken as being equal to 850 cub. in., or 3 gal. of water per 20 cub. ft. of air-gas produced. In the country where no water supply is available, the small amount of water required may be readily pumped up, or even carried up, to a barrel or tank placed in the roof. this labour being much less than that required for the trimming and cleaning of oil lamps.

To enable the worker readily to calculate the water required for any other size of ram, the following data will be found useful: 1 gal. = ·1605 cub. ft., which = 277·27 cub. in.; 1 cub. in. of water at 4° C. or 40° F. = 252·9 gr.; 1 cub. ft. of water at 4° C. or 40° F. = 62·43 lb.; 1 gal. of water weighs 10·02 lb.

It will be seen from the illustrations that no packing is required on the ram tube, as if the two tubes just slide nicely one in the other, the amount of water that will leak past will be negligible. As a matter of fact. this absence of packing has a slight advantage. When the plant is first started, the ram tube is full of air. whereas it is desirable that the tube should be nearly full of water, so that when the ram is in the highest position the water stands higher in the ram tube than in the tank, and thus assists the air-bell to descend. In practice it will be found that the surplus air will manage to work or leak past the two tube surfaces, and what air remains in the ram tube will serve to act as a cushion, and render the working of the apparatus smooth and free from shock or water hammer. The writer fitted an air-tap to the top of the air-bell, so as to be able to let out the air from the top of the ram tube ; but in practice this proved to be quite unnecessary.

It is, as already stated, advisable to solder three or four stays from the bottom of the outer ram tube to the sides of the air-bell, so as to keep the tube truly concentric with the air-bell and strengthen the whole.

To render the water discharge silent, the end of the exhaust pipe E X (Fig. 6) should dip down about 2 in. under the surface of the water in the tank. The air-pipe E is fixed as shown in Fig. 6, and connected by a bend to pipe F, while provision is made for draining any water from this pipe by means of a drain cock or drain tap fixed to D^1.

The Air-valves.—The pipe F slides over the bend from pipe E for some 4 in. or 6 in., thus forming a water-sealed joint. As, however, there is a partial vacuum in pipes F and E during the suction stroke, this joint must be packed as well, or a union may be used to couple F to the bend. The valve boxes are shown in Fig. 7, D being the suction valve box and G the delivery valve box.

On the air-bell rising, the suction causes the atmospheric pressure to overcome the water seal in D (the funnel pipe dips ¼ in. below the water surface), and allows the air to flow from the funnel pipe through D, down pipe F, and by way of pipe E (see Figs. 6 and 7) into the air-bell. The water in the delivery box G will merely rise up the dip pipe for about 2 in., so that no gas can be sucked back from the carburettor through G. The dip pipe in G dips a bare ½ in. below the water level. When the air-bell descends, the air is forced up pipe F, and, overcoming the ½-in. water seal in G, finds its way through pipe H to the carburettor B. The air cannot escape by either of the funnel pipes in D or G, as the air-bell can only produce a limited pressure of about 2 in. of water, and the water merely rises up about 2 in. in these funnel pipes to correspond. It will thus be seen that the valve boxes D and G are water-sealed, and can never get out of order or leak so long as the water seal does not evaporate. A small tube is taken from the exhaust E X to each of the funnels, so that at every exhaust stroke of the ram a little water finds its way into the funnels, and thus keeps the water level correct in the two valve boxes. Any excess of water is carried away by the level setting spouts I (Fig. 7). The bend pipe H slides over the pipe H^1, and dips down at least 6 in. below the tank water level, the pipe H^1 being carried up at least 1½ in. above the tank water line. This joint is purely a water-sealed joint, no other packing whatever being required. The valve boxes D and G are carried by the bridge piece C^1, which is fixed to the tank sides and can be readily removed by uncoupling the joint at F, and lifting the boxes and bridge piece away from the tank.

Air-gas cannot be pumped through a water-sealed valve, such as D or G, as this would result in the petrol being washed out of the gas. If passed through paraffin or petroleum the result is almost as bad ; while, if the gas is passed through petrol, the gas is enriched and the petrol seal is evaporated. In other words, air-gas cannot be passed through a water or oil seal without undergoing a change that is more or less objectionable or is fatal to its utility. Where a liquid seal is essential, mercury must be employed.

The diameter of the valve boxes D and G is 3½ in., and the diameter of the dip pipes ½ in., and as the volume of a pipe varies as the square of its diameter, it will be evident from Fig. 7 that a pressure equal to even 6 in. of water would fail to overpower the water valves, and as this pressure is in excess of anything the apparatus can possibly produce, there is no risk of failure at this point.

The tubes and valve boxes must be accurately made, and the outside water level clearly marked, so that the dip pipes are submerged to the proper level when in use.

The Carburettor.—The carburettor is of the wick type, and is shown in section in Fig. 13. The petrol storage tank B is mounted on the top of the carburettor, and the petrol feed to the carburettor chamber U is by means of a $\frac{3}{8}$-in. pipe E, the feed being on the well-known "bird-cage" principle. The air-pipe P just reaches down to the level of the petrol in the chamber U. So long as the opening at the lower end of this pipe is covered by the petrol, no further supply of petrol will be fed by the pipe E from the tank B. If, however owing to the wicks using up the petrol in U, the lower end of the pipe P becomes uncovered, then air will get up the pipe P into B, and allow petrol to be fed down E to U, until the lower end of the pipe P is again just covered. This principle is used in the water glasses sold by all dealers for birdcage and poultry runs (see Fig. 14). The stopper at the top of B must be a good tight fit, while a tap T must be provided as shown, so as to prevent waste of petrol when the tank B, together with the outer casing of U, is lifted off to allow the wicks to be inspected or renewed. Pipes P and E are soldered to take B, but only slide into the inner carburettor tank H^2.

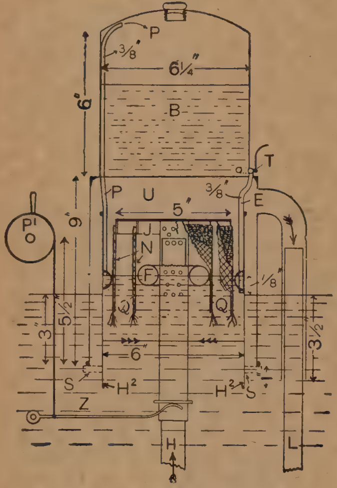


Fig. 13.—Air-gas Carburettor

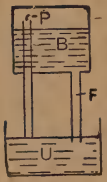


Fig. 14.—Birdcage Feed for Air-gas Plant

This tank B and outer casing are in one piece, and connect by a water-sealed bend to the delivery pipe L, as clearly shown in Fig. 8. They are supported by cross-pieces S (shown dotted) fixed to the outer water tank. These cross-pieces also support the inner carburettor tank H^2, which is simply a cylinder 6 in. in diameter and 7½ in. high. The wick carrier J consists of a lid-shaped piece, to the centre of which is soldered a brass tube that slides freely up and down the pipe H, and has a series of holes drilled, so that the air from H can readily find its way to the wicks. A brass collar is soldered to the bottom of the tube, so that the forked end of a lever Z can engage it, and thus allow the tube and with it the wick carrier to be readily raised or lowered, sliding up or down the pipe H. A pulley P^1 fixed to the water tank, and so arranged as to work rather tightly, carries a cord which is attached to the lever Z, so that by turning the pulley the lever Z, and with it the wick carrier can be raised or lowered.

To the lid J of the wick carrier are soldered two concentric rings or cylinders of rather coarse-mesh copper gauze N, on the outer surface of which the circular wicks Q are placed. These wicks are slipped over the gauze cylinders, like a stocking or mitten. The higher the wicks stand out of the petrol, the larger the air-exposed wick surface, and hence the richer the air-gas mixture produced. These wicks must be made of thick cotton, knitted like a plain stocking, and of such a size that they can just be drawn tightly over the gauze cylinders. The gauze cylinders are 5 in. and 3½ in. in diameter and about 4 in. high.

The wicks should be made from thick knitting cotton (not wool), such as is used for making bed quilts, the size being about No. 6 or No. 4; and the wicks must be knitted very open, using large-size needles for the work.

The exposed area of petrol in the carburettor chamber is the area of a circle 6 in. in diameter less the area of the sliding tube, which is roughly 1¼ in. in diameter, so that the exposed surface of petrol is roughly 27 sq. in. Assuming the wicks stand 4 in. high above the petrol level, and taking the exposed area as being the inner and outer surface of the two cylinders, the total wick surface exposed to the air is roughly 106 sq. in.; that is to say, practically four times as great as the exposed petrol surface. Hence this design of carburettor is almost free from any tendency to "fractionating" trouble. In order to prevent, as far as possible, the air reaching the free surface of the petrol, a semicircular ring of metal is soldered to the sides of the inner tank U, just about the petrol-level line, this ring just allowing free clearance for the outer wick, so that this wick can be freely moved up or down. The rounded section of this ring ensures that it does not catch or prevent the outer wick from being raised or lowered. To keep the air from the petrol surface inside the wick carrier a float F is used. This loosely fits the carrier tube, and just clears the inner gauze cylinder. This float, whose shape is simply that of a round ring, can be either of very thin brass or it may be of cork. The seam if of metal must be well soldered, as any pinhole would allow petrol to get inside the hollow float and cause it to sink.

A similar float may be used in the space between the two gauze cylinders; but as this area is only 10 sq. in., the amount of fractionating due to this surface can be neglected.

A carburettor made on the above lines, but without any attempt to prevent air reaching the free petrol surface, has in practice proved almost free from fractionating; so that the float F may, if desired, be neglected. When the plant is at rest, the air left in the carburettor chamber U naturally becomes more charged with petrol vapour; so that when after a long interval of rest the air-bell starts to jump again, a volume of air-gas more rich than desirable is driven into the gasholder C (Fig. 6). For this reason it is advisable to keep the volume of the carburettor U (Fig. 13) as small as possible as regards its air space, while the diameter of the outer casing of U (which has fixed to it the bend connecting to pipe L) should be such as to just slide easily over the inner cylinder of U, say 6½ in. From the pipe P (Fig. 6), which leads to the gasholder bell, a small branch pipe T with tap R is tapped off, so that the gas mixture can be tested on a test burner fitted to the pipe T. If the gas mixture is found to be too rich, the wick carrier is lowered so as to expose less wick surface. If the mixture is too poor, the wick carrier is slowly raised, until the test burner shows the mixture correct.

When the petrol tank B (Fig. 13) is lifted off, it, of course, carries with it the two pipes P and E and the outer casing of the carburettor chamber U, so that the inner chamber H^2 and the carburettor wicks can be readily examined. In order to prevent loss of gas, which when B is lifted off would flow back through pipe L from the gas-bell C (Fig. 6), a tap is placed in pipe P (Fig. 6) between the carburettor and the gas-bell.

From Fig. 13 it will be noted that the petrol in U floats on the surface of the water, the dividing line between petrol and water being shown by triple arrow heads. Thus any water that may condense in U will sink through the petrol, and in this way be automatically drained away from the carburettor. With a float-feed carburettor (such as used for motor-car work, and also for some air-gas plant on the market), any alteration in the specific gravity of the petrol will alter the float adjustment and level of petrol, and, of course, the adjustment of the carburettor. The birdcage feed here adopted does not vary the adjustment with alteration in the petrol, the level of the liquid being solely determined by the position of the lower end of the air-pipe P (see Fig. 13).

A Precaution.—This carburettor has one slight failing, namely, as the petrol in the tank is fed down to the carburettor the petrol tank is filled by petrol gas. Thus, when the stopper is unscrewed, no light must be brought near, as the mixture, owing to the air standing over the petrol, may be rich enough to be explosive. This fault applies to all petrol-storage tanks, and they should never be filled or examined, except in daylight. It may also be pointed out that it is dangerous, and a punishable offence, to pour petrol down any drain, as this causes very serious danger to sewer men.

The Gasholder Bell.—This is also made of stout zinc, the same as the air-bell, but 12 in. in diameter. Four stays O are soldered to the bottom of the bell and to a ring at the centre, which loosely slides up and down the centre pipe M (see Fig. 6). The bell is also guided in its travel up and down by guides, in the same manner as the air-bell, while a U-shaped pipe W allows the gas-bell to deliver to the house mains Y.

The gasholder bell acts the double purpose of a gas-storage tank and a pressure regulator. It must be weighted so as to give about 1½ in. water-gauge pressure in the service pipes, the air-bell being weighted so that it is just able to raise the gasholder bell. The higher the gas-bell rises out of the water the more effort will be required by the air-bell to still further raise the gas-bell. Again, the lower the air-bell sinks, the less effort can it produce; so that in practice there is no danger of the air-bell over-pumping and lifting the gas-bell too high. It is, however, advisable to fit stops at the upper ends of the upright guide rods G R (Fig. 7), so as to prevent either the air-bell or gas-bell being raised too high. The adjustment of the gas-bell and air-bell is effected by putting shot into small cups that are soldered to the top of the bells.

Condensation Drainage.—Owing to the air being cooled down to the temperature of the tank water as soon as it enters the gas plant, very little trouble with condensation is experienced. The pipes D^1 and B^1 (Fig. 6) are carried through the tank bottom, with a leather washer between the flange and the tank, and are secured by a lock-nut underneath the tank bottom. At D^1 and B^1 drain taps are fixed; or the pipes may be carried down, so that the ends dip 2½ in. to 3 in. below the water surface of the small drain cans or seal pots, and thus act as automatic drain traps. In this case the tank should be carried by four legs about 12 in. high. In this way pipes E, F, H^1, and H^2 (Fig. 6) are kept clear of any condensed moisture. Pipe M^1 should be fitted to be cleared from P or M. When the gas is fed to the supply pipes its temperature will be raised somewhat, and therefore no condensation in the service pipes will take place.

The Gas-pressure Gauge.—A gas-pressure gauge is almost indispensable, in order to allow of the apparatus being adjusted, so as to give the proper pressure in the service or supply mains. This gauge consists of a U-shaped glass tube filled to about half its height with water, one end being left open, while the other is connected to the gas-pipe (see also pp. 570 and 571). The U-tube being supported vertically, the difference in the water levels in the two limbs of the tube gives the difference between the gas pressure and the atmospheric pressure. Of course, the gas pressure is always above that of the atmosphere, and is expressed as so many inches or fractions of an inch of water. To make the pressure gauge more easily readable, the water should be stained with a little indigo sulphate or even ordinary writing ink. It is not advisable to leave a pressure gauge permanently connected under pressure, as a fracture of the glass tube would result in an escape of gas. A tap should therefore be provided, so that the gas may be turned off from the gauge after the readings have been taken. The glass U-tube should not be less than ⅜-in. bore, otherwise capillary action will introduce a slight error into the reading.

Gas Burners and Mantles.—Air-gas is burnt on incandescent burners very similar to the well-known Welsbach incandescent burners used for ordinary coal-gas; but the air-gas burner differs from the coal-gas burner in one important point. With air-gas it is not necessary to mix air with the air-gas at the burner, except in the case of very "rich" air-gas. Both upright and inverted mantles are used, special burners and mantles being obtainable. The writer, however, has always used ordinary coal-gas mantles and found them quite satisfactory; in fact, they appear to last longer with air-gas than coal-gas, and this is attributed to the fact that there is no explosion when lighting air-gas. All kinds have been tried, and all seem as good as with coal-gas, but of the inverted "Welsbach," "Veritas," and "Glasmi," the writer has dealt with some thousands (for air-gas) with every satisfaction. For upright mantles the Nos. 1 and 2 "Kern" have been mostly used, but experience shows that the inverted do better service than the upright in most cases.

With regard to the actual burners, it is not possible to use any coal-gas burner for air-gas without some alteration. The Welsbach-Kern burners, sizes No. 1 or 2, can be used by simply broaching out the inner nipples to pass about double the usual volume of gas, provided the air-gas is "rich," in which case there must be a collar to regulate the air supply into the burner. For "poor" gas there is no air inlet to the burner, and, as a rule, the gas will only burn from gauze or fine holes.

Test Light and Pilot Light.—This consists of an inverted burner without a mantle, which is connected to the pipe T (Fig. 6). This burner gives a cone of flame, from the colour of which one can readily judge when the gas mixture is correct. If the flame is yellow or has a yellow centre, the mixture is too rich, and the wick carrier of the carburettor must be slowly lowered. When the flame has a uniform blue tinge, with only the merest trace of yellow in the centre, the gas mixture is correct. Very little practice is necessary to regulate the plant.

Gas Pipes and Gas Fittings.—These are the same as ordinary coal-gas fittings; in fact, air-gas is less liable to leak than coal-gas. In this respect air-gas has a great advantage over acetylene, which latter gas demands the use of taps and movable joints that are most carefully ground in.

Air-gas has no ill-effect on iron, compo, lead, brass, or copper tube, but it has a solvent action on oil and on rubber. For this reason, oil should not be used in jointing pipes, nor should rubber be used for washers, tubes, etc.

With iron piping it is, therefore, inadvisable to use paint or red-lead and oil for the joints, as in time the petrol might act on this material. The writer has found that red-lead or litharge mixed with gold-size is quite unaffected by air-gas. At the same time, it may be mentioned that in the case of a plant with iron piping and ordinary red-lead or paint at the joints, no leakage trouble was experienced over a period of two years after installing.

Dry red-lead made into a thick cream with a solution of gum arabic answers quite well. Ordinary dry gum (obtainable from any oilman) is dissolved in water (which requires about forty-eight hours), sufficient of which is used to make the gum strong and sticky to the fingers, and this gum solution is employed for making the dry red-lead into a firm paint. Red-lead and gum solution made into a putty (or a mixture of gum solution and plaster-of-paris) can be used for any bedding-on joints that may be required. For washers, plain leather, unoiled, may be used. For flexible tube, the metallic kind is available.

The testing of joints for any leaks is best done by brushing a solution of soapy water well over the joint. If the very slightest leak (often too small for the sense of smell to detect) exists, a bubble will at once point out the fault.

Protection of Plant from Frost.—The protection of the gas plant from frost is necessary when the plant is fixed in an exposed position. If much frost is likely to be experienced it is advisable to fit a heating coil of copper to the water tank, connecting one end near the bottom and the other end of the coil near the middle of the tank. A lamp or gas jet placed under this heating coil will then just keep the tank water from freezing during very severe weather. Petrol is unaffected by frost.

Gas Governor.—This can be dispensed with in the present gas plant, as the gas-bell practically acts as a pressure regulator. The rising holder will in practice be found to produce an almost constant pressure, the slight variation (due to the fact that the diminution in weight of the gasholder, as the latter descends into the water, is naturally increased, and therefore the pressure that the holder "throws" is reduced) being of no moment.

Cooking and Heating by Air-gas.—Air-gas can be used for cooking and heating, and has one great advantage, namely, the flame is entirely free from soot, the large amount of air present in air-gas being more than ample to ensure complete combustion. Special burners can be obtained; but it is not an expensive matter to change the burners, and so convert an ordinary gas stove to one suited for using air-gas.

Fire Risks.—In conclusion, a word may be said as regards fire risks. The leading insurance companies will pass at ordinary rates any house lighted by an air-gas plant; but the reader should at once advise his insurance company that air-gas plant has been installed, so as to avoid any dispute. The insurance premium will not be affected in any way.

Although, as has been shown, a 2 per cent. or even richer mixture is considered to be non-explosive, it is well to reduce any risk to a minimum by putting a large cap on the head of the gas delivery pipe, the greater part of this cap being Davy-lamp wire gauze. Some gas-plant makers use a valve, but in all cases it is wise to make a provision of some kind. With "poor" gas, the wire gauze in the burner is sufficient protection from lighting back from the burner, but this is not so as against lighting occurring at leaks or irregular places.

Renewing Broken Sash Cord

FIG. 1 (opposite) is a part elevation of a pair of double-hung sashes. In renewing a broken cord, the first thing to do is to insert a stiff screwdriver, or an old chisel, between the joint of the fillet and casing at A and B. Prise it out well in the centre till the brads are free. Bend the fillet out well in the centre, and this will cause the mitred ends to leave their joints with the top and bottom fillets respectively. Another way is to lower the top sash, and make an inclined cut at C with the tenon saw. Then the lower part of the fillet only need be removed. The object in trying to do as little damage as possible is to save the trouble of painting or graining. With the removal of this fillet, the lower sash can be swung round, and the broken cord removed from the groove in the sash frame (see D, Fig. 2).

Next remove the weight from the window frame. This is effected through openings made for the purpose in the frame at E and F (Fig. 3). The openings are neatly covered with fillets, and are sometimes difficult to locate, as the subsequent layers of paint tend to conceal the joints. A few light blows will start a crack in the paint at the joints. Then insert the screwdriver at the top and bottom ends of the fillets at G and H (Fig. 3), and prise out evenly. If very tight, bore a hole with a brace and bit as shown by the dotted lines F, and knock out the two parts. Then remove the weight, insert the new cord over the pulley J, pull it through the opening, and fasten it to the weight. Replace the latter in the frame, swinging the sash in place temporarily, and haul the weight up till it touches the pulley, keeping the cord quite close to the sash. Then let it drop back 2 in., and mark on the cord the position of D or the top of the sash (Fig. 2) with blacklead or chalk. Swing the sash out, and support it at a higher position. Then fix the line or cord in the groove D (Fig. 2) with copper tacks or short clout nails, cut off the surplus end of the cord, replace the sash and fillet, and stop the brad holes, etc., with putty coloured to suit, or touch up with paint.

If the top sash line has to be renewed, the fillet must be taken away as just described for the bottom sash; also the parting slip K (Fig. 3). This slip is housed into a shallow groove, and is not bradded or otherwise secured. It is, of course, fixed with paint, and will require prising out of its position. When this is done, both sashes can be removed from the frame. In Fig. 2, the lower part of the fillet L and also the parting slip are removed, the line indicated by the letter M representing the outside square-edged part of the framing, which cannot be removed.

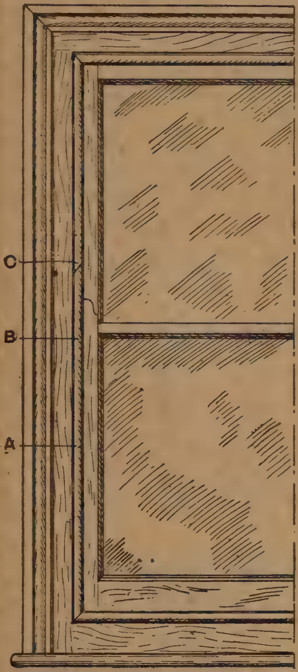


Fig. 1.—Interior View of Window with Double Sashes

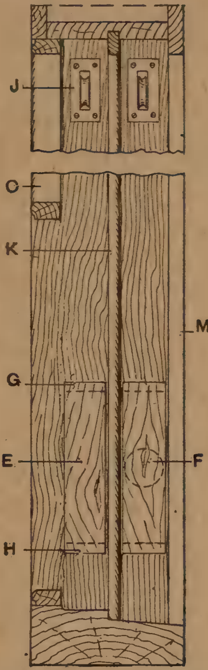


Fig. 3.—Part Enlarged Vertical Section with Sashes and Part Inner Fillet Removed

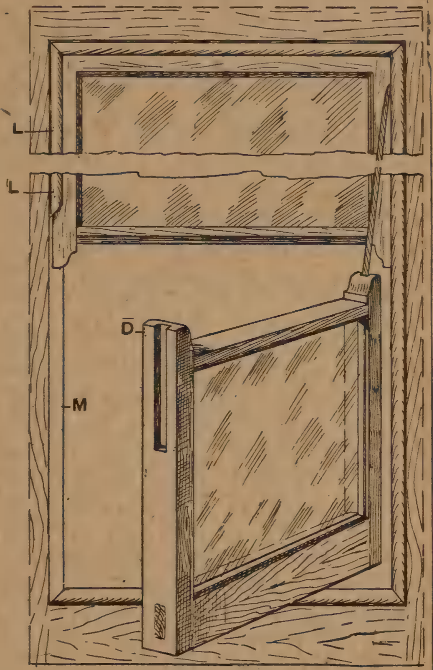


Fig. 2.—Part Interior Elevation with Lower Sash Clear of Frame

Simple Bricklaying

THERE is, perhaps, no other kind of constructional work occurring in and about the house more capable of being satisfactorily managed and carried out by the amateur than bricklaying, and there is none so generally avoided by him. This may be due to the bulkiness of the materials used, and the dirty nature of the work, but it is "clean dirt." The amateur bricklayer's tools are neither numerous nor expensive, many of them being adaptations of the general tools about the house, and others being easily made or cheaply procured. The trowel—a very familiar tool—is an essential.

Bricks.—The bricks may be either "Flettons" or "stock bricks," obtainable from any builders' merchant, but should there be a firm of house wreckers in the district, old bricks of good enough quality can generally be obtained from them at very cheap rates.

Sand.—The sand can be bought by the load or cubic yard, or by the bushel, and care should be taken to see that it is clean and sharp. By this is meant that there should be no clay, pieces of coal, wood, etc., amongst it. Wood is commonly present in the case of river sand, and when closely inspecting a handful taken at random, the grains of the sand should be found angular in shape. A yellowish stain on the hand left after throwing the sand down, indicates the presence of clay or loam in quantity, necessitating the washing of the sand before use.

Cement.—Portland cement can also be obtained through builders' merchants by the sack or bushel. A sack contains, when full, 2 bushels.

Lime.—Greystone lime is the quality to be employed for the lime mortar, and can be purchased by the cubic yard or bushel.

Having obtained these materials, they should be neatly deposited on or near the site of the work; proper protection from the weather must be provided for the lime and cement, and it is advisable to keep them in a shed until they can be used, as exposure soon spoils them.

The number of bricks required can be arrived at approximately by dividing the cubical capacity of one brick, which measures 9 in. by 4½ in. by 3 in., into the cubical contents of the work in hand, obtained by multiplying its height by its length by its depth. The quantity of mortar required will be dealt with when describing how this substance is mixed.

Excavating.—The digging of the trench in which the wall will be built is the first job. Fig. 1 is the cross section of a garden wall, the dug trench being 12 in. deep. This depth is the minimum under the conditions shown, as it is the usual practice to have the top of the projecting brick foundation (the "footings") at least 3 in. below the general ground level, in other words, one course of the fair face of the wall is below the ground. The depth of the trench is naturally regulated by the condition of the soil found at the

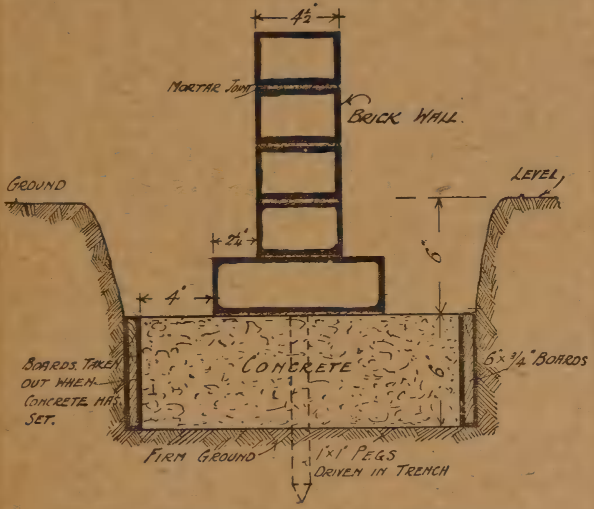


Fig. 1.—Diagram of Trench, Foundation, etc., for Half brick Wall

bottom of it when opened up. No one would attempt to build on soft garden soil or mud, and common sense will have to be exercised to satisfy oneself as to the weight-bearing capabilities of the earth at the bottom of the excavation, taking into account the purpose for which the proposed brickwork is to be used. A pick-axe or iron crowbar driven into it will give some idea as to the solidity of the soil.

The Concrete Foundation.—The trench should be boarded on each side as indicated in Fig. 1 to keep in shape and position the concrete that forms the foundation for the "footings." Pegs are driven into the bottom of the trench on the centre line, about 2 ft. 6 in. apart, for the purpose of keeping the top level of the concrete correct in the centre, it naturally being essential that the surface of the concrete be level and true where the bricks are to come.

Fig. 2 is a photographic illustration of the end of such a trench, the boards being strutted apart with short pieces of wood.

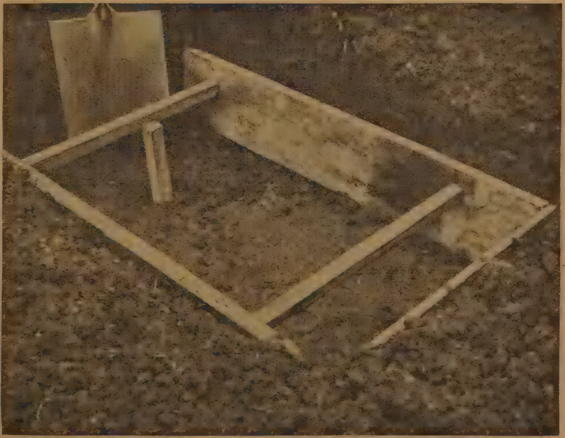


Fig. 2.—Excavation, with Boards and Struts

A peg driven to the level of the concrete and also corresponding to the level of the top edge of the boards at the sides is shown. These pegs are allowed to remain in the concrete, but the struts are withdrawn as the concrete reaches their level, and the boards are taken out when the concrete has had proper time to set.

Mixing and Laying the Concrete.—The mixing of the concrete should be carried out on a platform of clean boards. The ingredients should be carefully measured, turned over twice dry, wetted through the rose head of a water-can, and then thoroughly incorporated with one another. For *lime concrete*, use 1 pail of grey-stone lime (ground), and 4 pails of clean broken brick (moderately small). Broken brick is an excellent base for lime concrete. For *cement concrete*, use 1 pail of portland cement, 1 pail of clean sand, and 4 pails of stone ballast.

The theory of concrete making is that the interstices (spaces between the fragments) of the ballast, broken brick, or other "aggregate" or base, should be filled with the sand, and the interstices of the sand should be, in turn, filled with the cement. These amounts can be easily ascertained in the following manner:

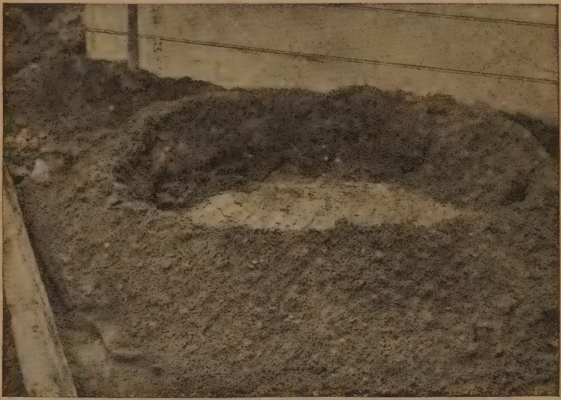


Fig. 3.—Mortar Making: Ring of Sand on Clean Platform

Take a quart measure, for instance, and fill into a pail, say, four quarts of stone ballast. Then pour water into the pail (using the same measure) until it reaches the level of the ballast. Should it take just one quart of water to do this it will be known that for every four measures of stone ballast one measure of sand must be added to fill the "voids" as the spaces are called. A similar operation is gone through in the case of the sand to ascertain the proportion of cement required to fill its voids.

The above is the scientific and the only correct way of proportioning concrete, but should it be thought too much trouble, the proportions already stated may be adopted with confidence

The concrete should be carefully deposited in the trench smoothed, and levelled off with the back of the shovel or with a wooden rule worked along the edges of the board, and allowed two or three days to set hard; a week-end period is a good time. A little portland cement added to the lime concrete will hasten the setting and harden the concrete.

Mixing the Mortar.—The next step is to prepare the mortar. This appears to be a very simple matter, but it needs to be properly done. In the case of lime mortar, a ring of sand is formed as shown in Fig. 3, on a platform of boards. and in it the measured quantity of greystone lime in lumps is placed as shown by Fig. 4. A pail is taken filled with water, and by means of the hand the water is tipped on to the live lime. Upon doing so, the lime immediately starts to hiss and steam violently, disintegrating and rapidly falling to pieces. This process is termed "slaking." About three-quarters of an hour is the time occupied in doing this, and to ascertain if the action of the water is complete, take the shovel and probe the now soft white stiff mass to feel if there are any lumps in it. It is very necessary to make certain on this point, and should there be any doubt about it, allow the mortar bed to remain a short time longer. Then start from the outside of the sand and throw it on to the lime with a shovel, working all round the bed. Fig. 5 shows this being done. Next the whole is thoroughly mixed together and allowed to stand for two or three days before using.

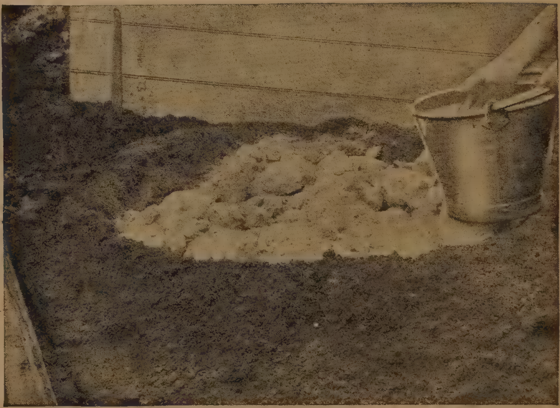


Fig. 4.—Mortar Making: Slaking the Lime

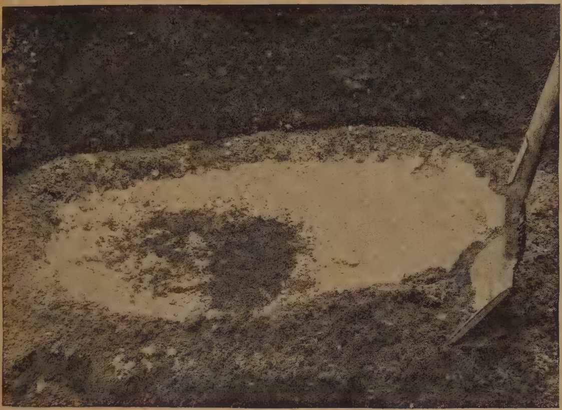


Fig. 5.—Mortar Making: Throwing the Sand on the Lime

The proportions of sand to lime to make an average strong mortar are as follow: 1 pail of greystone lime, and 4 pails of clean sharp sand. Cement mortar is easier to make, but in many cases is unnecessarily strong and certainly more expensive. It should be prepared on a "banker," as it is termed, this being a series of boards battened together on the bottom, with a wooden guard or curb about 4 in. high strongly nailed on three sides (see Fig. 6), the two side guard boards being rounded at the front; the size is usually 2 ft. 6 in. by 2 ft. A banker is easily constructed, and it is advisable to make one even though the proposed work be small. It keeps the mortar clean, and prevents waste of cement. The proportions to be used for cement mortar are as follow: *Strong cement mortar*—1 pail of portland cement, and 3 pails of clean sharp sand. *Medium cement mortar*—1 pail of portland cement, and 5 pails of clean sharp sand.

Should the work to be carried out be only a very small job, satisfactory results can be obtained by adding a 4½d. packet of portland cement (obtained at any oilshop) to a two-gallon pail two-thirds full of sand.

The approximate quantity of mortar required to lay properly about 200 bricks is prepared from 1 bushel of greystone lime and 4 bushels of sand. As a general rule the amount of water required in mortar making is one-third the total bulk of the other materials.

Building a 4½-in., or Half-brick, Garden-wall.—For the actual bricklaying, the worker must know how to arrange the bricks so as to "bond" them together. The proper and strongest bond in brickwork is obtained when no vertical mortar joints of one course coincide with those of the next course above or below.

The first example here taken is that of a half-brick wall (generally called a "4½-in. wall") with brick piers or projections measuring 4½ in. by 9 in. on the face, an arrangement very commonly used for a garden boundary or a south wall for fruit trees in a garden. The brick projections should not be less than 6 ft. apart (let the actual distance be a "brickwork dimension"—that is, a multiple of

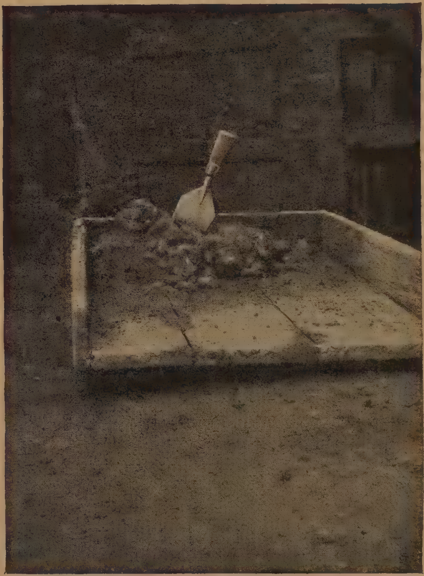


Fig. 6.—Cement Mortar on Banker

9 in.). Figs. 1 and 2 show the digging required. Fig. 7 shows the correct arrangement of the bricks for the foundation course, and for the first and second courses of the wall; the first and second courses are used alternately to the required height of the wall. Attention is drawn to the use of a half brick (a "bat") in the foundation course; without affecting the bond, this bat could be inserted on the other side of the adjoining brick in the position marked x in Fig. 7. The dotted lines indicate the proper position for the first course on the foundation course, which is only one course high, the wall being but one half-brick thick (that is, one-half the *length* of a brick). The rule is that for every half brick in the thickness of a wall there should be one course in the projecting brick foundation. See the table given on page 231.

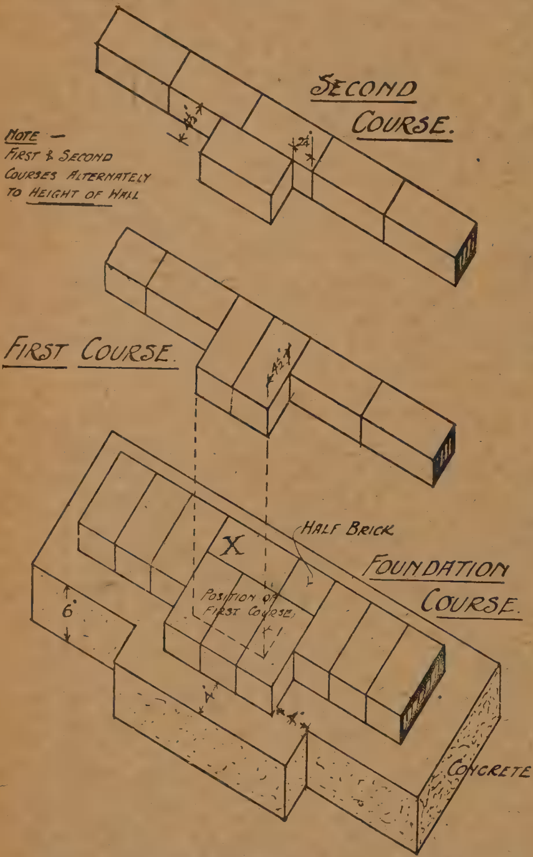


Fig. 7.—Concrete. Footings and Two Courses of Half-brick Wall with Projection

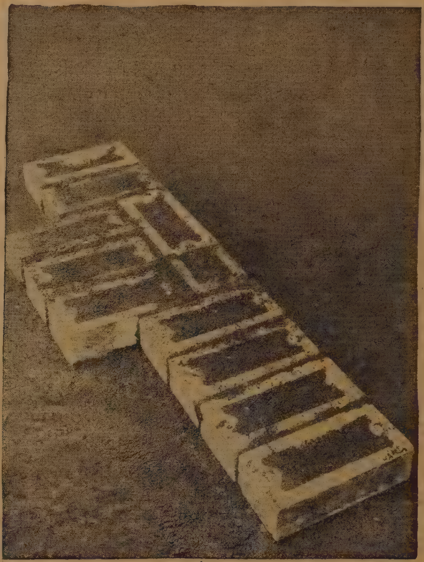


Fig. 8.—Foundation Course for Half-brick Wall

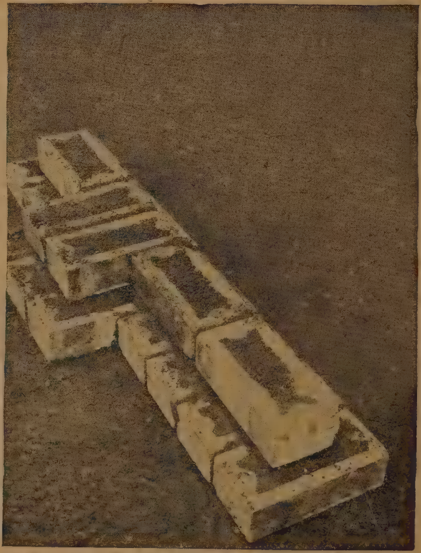


Fig. 9.—Foundation and First Courses for Half-brick Wall

TABLE OF BRICK FOUNDATIONS

Thickness of wall	*No. of courses of brick foundations or footings*
4½ in. or ½ brick	1
9 in. or 1 brick	2
13½ in. or 1½ bricks	3
18 in. or 2 bricks	4

The second course shown in Fig. 7 bonds with the first course, this being obtained by setting the bricks immediately behind the brick pier or projection, 2¼ in. and 6¾ in. respectively from the internal angles. The placing of the bricks to form the pier is very simple; by studying the illustrations it will be apparent that no two mortar joints come vertically over one another in the courses immediately above or below them, thus securing perfect bonding. Fig. 8 is a photograph of the foundation course, and Figs. 9 and 10 show respectively the first and second courses.

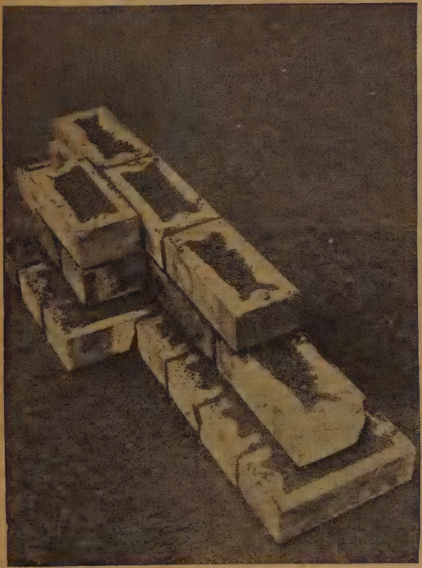


Fig. 10.—Two Courses of Half-brick Wall with Projection

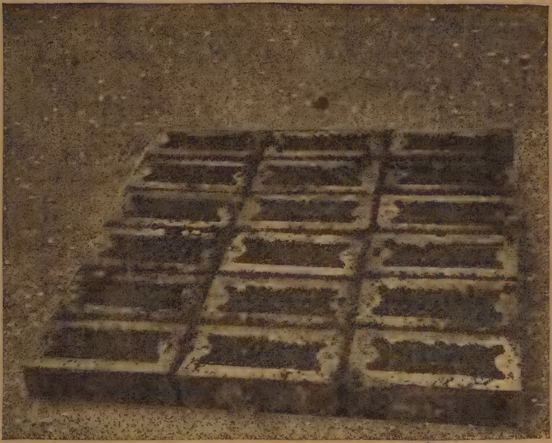


Fig. 11.—Brick Pillar: First Course of Foundation

Building a Brick Pillar.—The building of a brick pillar which is to act as a support is a fairly common job. An example will be taken of a square pillar measuring 14 in. on each face—such a pillar as would be adopted for carrying a beam over a workshop, etc. Referring to the table of brick foundations, it will be seen that a three-course foundation is necessary, the arrangement of bricks for this being illustrated by Figs. 11 to 13. The first and third courses consist of whole bricks laid across one another. while the second course differs from the

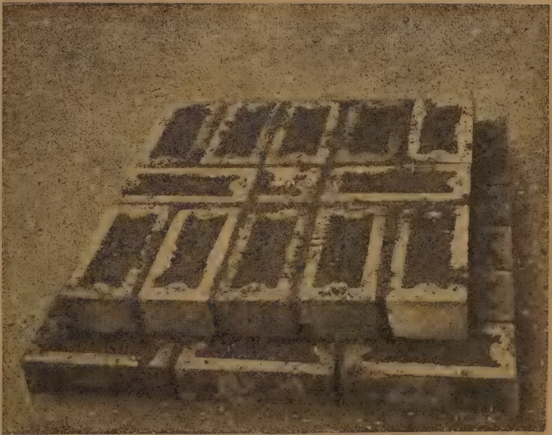


Fig. 12.—Brick Pillar: First and Second Courses of Foundation

others by introducing a half brick in the centre backed in with two whole bricks. In Fig. 14, which is a dimensioned diagram of foundation and the first two courses of the pillar, an alternative arrangement is shown for the third course of the foundation, the bricks being turned the other way; either arrangement is satisfactory. The dotted lines show the positions of the successive courses, and each course sets back 2¼ in. all round on the one below it, in accordance with accepted practice. The first two courses of the actual pillar are shown built in Figs. 16 and 17; they consist of whole bricks on the outside, with a half brick in the centre. There is a weakness in this method of constructing a pier which cannot be obviated, except by cutting every brick used, an alternative which the amateur will be glad to avoid. By comparing courses A and B (Fig. 14) it will be seen that there is a straight joint throughout the height of the pillar corresponding with the shape of the centre half brick. This defect can be minimised by the introduction of three

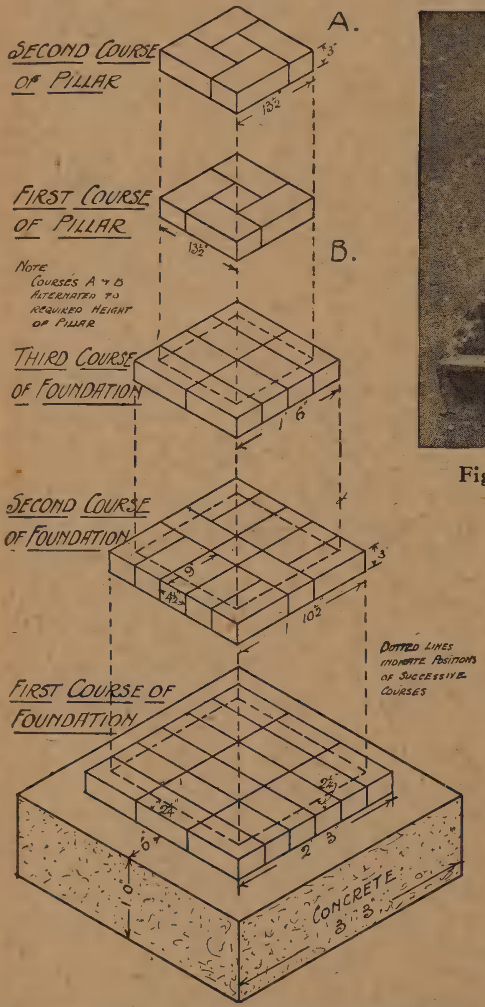

A.
SECOND COURSE OF PILLAR
3"
13½"
FIRST COURSE OF PILLAR
13½"
B.
NOTE
COURSES A & B ALTERNATED TO REQUIRED HEIGHT OF PILLAR
THIRD COURSE OF FOUNDATION
1' 6"
SECOND COURSE OF FOUNDATION
3"
9"
4½"
10½"
DOTTED LINES INDICATE POSITIONS OF SUCCESSIVE COURSES
FIRST COURSE OF FOUNDATION
2¼"
2¼"
6"
2' 3"
0
CONCRETE
3' 3"

Fig. 14.—Brick Pillar: Concrete, Footings and Two Courses of Pillar

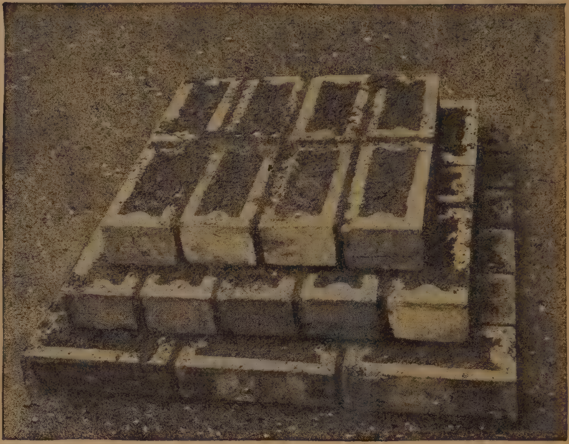


Fig. 13.—Brick Pillar: First, Second and Third Courses of Foundation

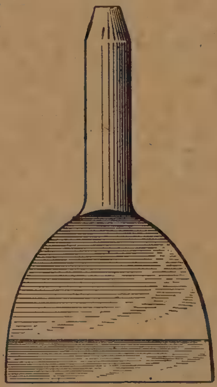


Fig. 15.—Bricklayer's Chisel or Bolster

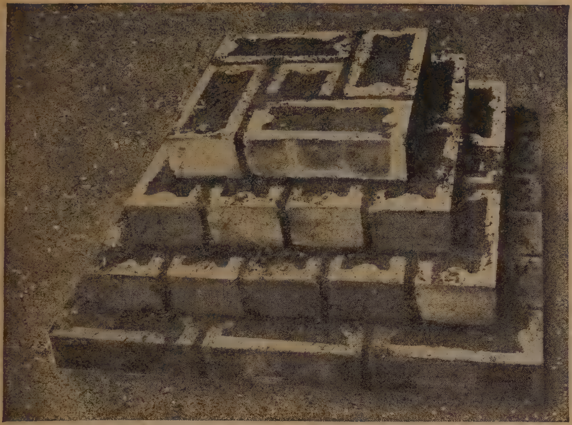


Fig. 16.—Brick Pillar : First Course of Pillar

short lengths of hoop iron built into the pillar at every fourth course to tie the work together. The first and second courses of the pillar are repeated alternately until the desired height is reached, and in any case this height should not exceed 8 ft. or 9 ft. The higher the pier, the less is the load that it can safely carry.

Method of Cutting Bricks.—The method of cutting bricks is shown in Fig. 18. It is not to be expected that the amateur could, with any certainty, cut a brick by the bricklayer's method of hitting it with the edge of a trowel, so a bolster or bricklayer's chisel (see Fig. 15) is used, this tool costing about 2s. 6d. If the expense is objected to, the work might be done with an ordinary hatchet, but do not use this as when chopping wood, but place it in position and strike its head with a hammer. The amateur's safest method of cutting a brick is as follows: A line is made on each side of the brick where the cut is to come, the edge of the bolster is placed on each line in turn, and the head lightly struck with a club hammer (see Fig. 18). The brick is then laid down evenly on a firm surface, the "frog" or hollowed side down, and with a sharp blow with the hammer on the head of the bolster, the brick is severed. A little extra trouble and care taken in cutting the bricks will be amply repaid in the finished appearance of the work, and will in the long run prove economical.

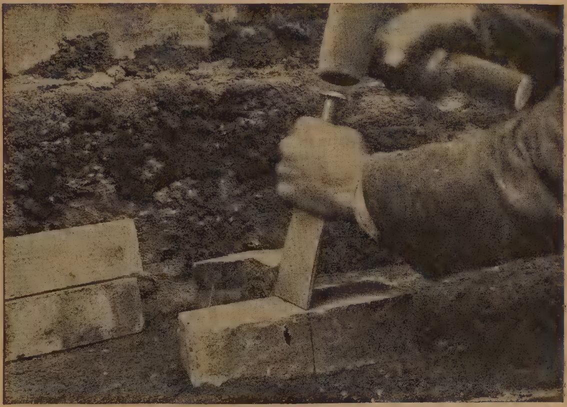


Fig. 18.—Method of Cutting Brick

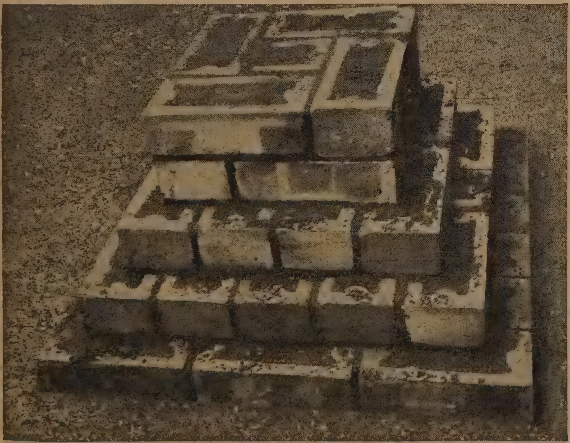


Fig. 17.—Brick Pillar : Second Course of Pillar

Building the Brick Base of a Greenhouse.—The base walls for a greenhouse, as shown in Fig. 19, can be easily erected. The formation of the courses is shown in

Fig. 20, this illustrating the mode of making a recess for the purpose of fixing the post or frame shown in position by the photograph (Fig. 26). The wall being 9 in. thick, there must be two courses of projecting bricks in the footings. and these will be arranged as shown in the diagram (Fig. 20), and in the photographs (Figs. 21 and 22). The concrete foundation under the brick footings is shown in Fig. 20 as projecting 6 in.. and in no case should it project less than 4 in. Fig. 23 shows the first course of bricks for an ordinary 9-in. wall, this course bringing the work up to the ground level; Fig. 24 shows the next course and the recess for the post. It will be noticed that there is a quarter-brick, 2¼ in. wide, in this second course, while the third course (see Fig. 25) has a half brick at the side of the recess, and whole bricks elsewhere. Attention is particularly drawn to the manner of laying the bricks to form the recess ("reveal") to receive the post. By the proper introduction of a three-quarter brick (6¾ in. wide) backed in with a quarter-brick the correct bond is obtained. The courses marked A and B in Fig. 20 are employed alternately in building the wall, and these are shown erected in Figs. 24 and 25. Of course, the recesses for posts or frames are of various sizes, but all of them are

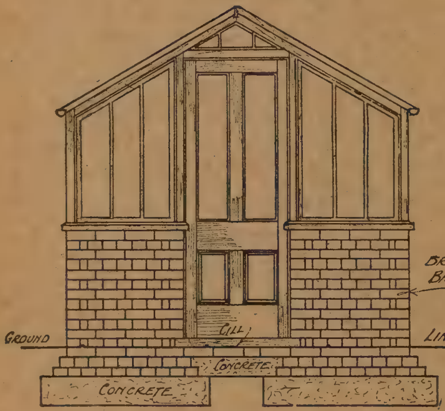


Fig. 19.—End Elevation of Greenhouse, Showing Brick Base Walls

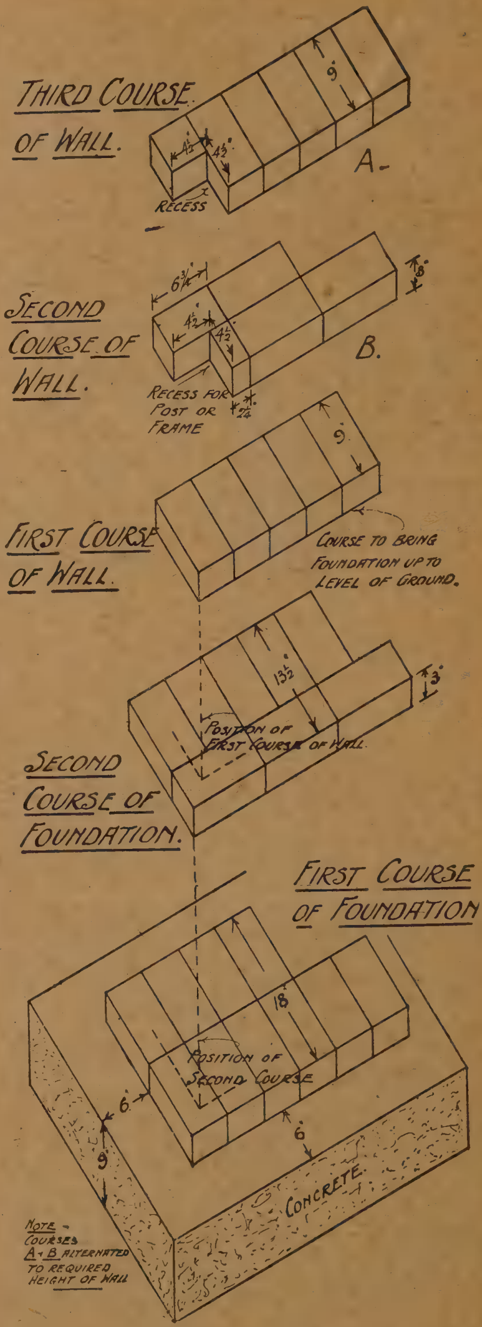
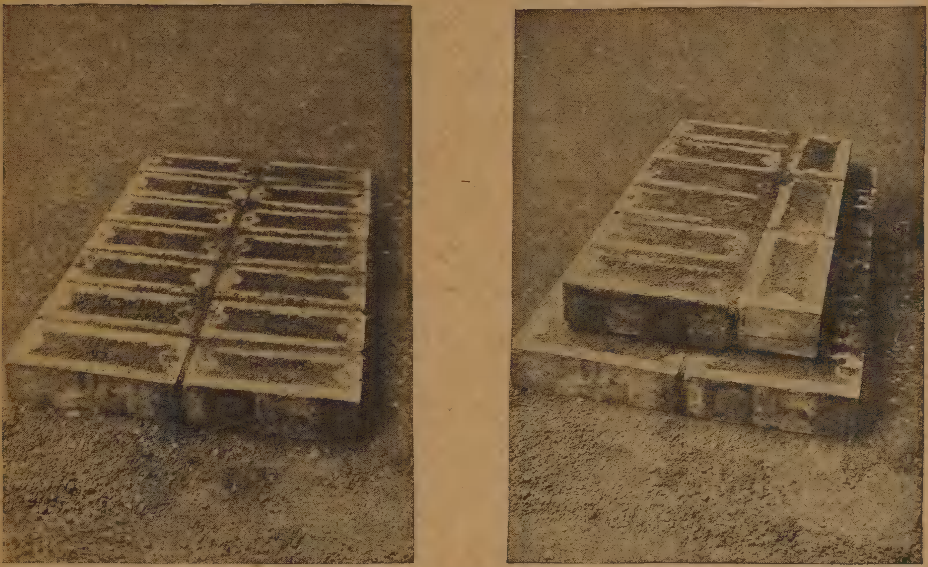
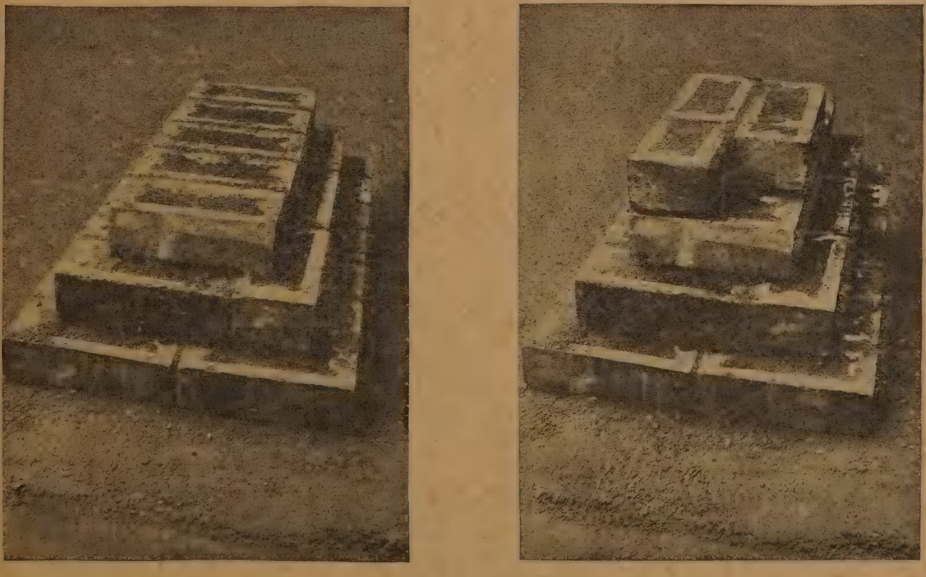


Fig. 20.—Concrete, Footings and Three Courses of Greenhouse Wall

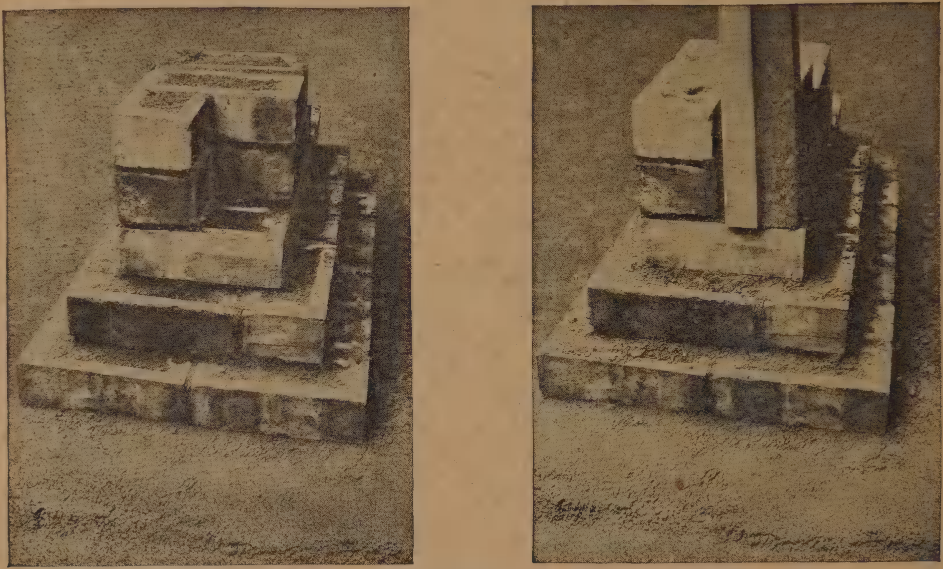


Figs. 21 and 22.—Foundation Courses for Greenhouse Wall



Figs. 23 and 24.—First and Second Courses for Greenhouse Wall adaptations of what is shown in Figs. 20 and 26.

All bricks in a wall are laid with the "frog" side or hollowed side uppermost. This will be seen by reference to most of the photographic illustrations in this chapter.



Figs. 25 and 26.—Three Courses for Greenhouse Wall, and Doorpost in Position

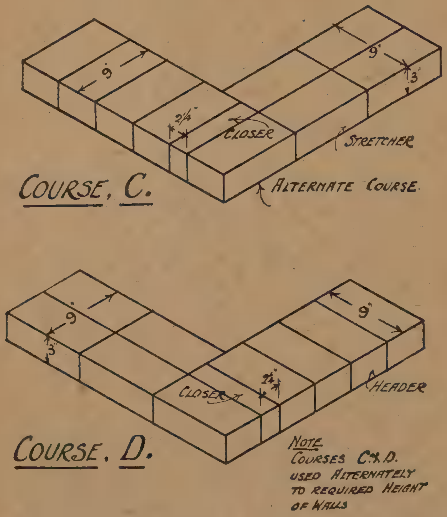
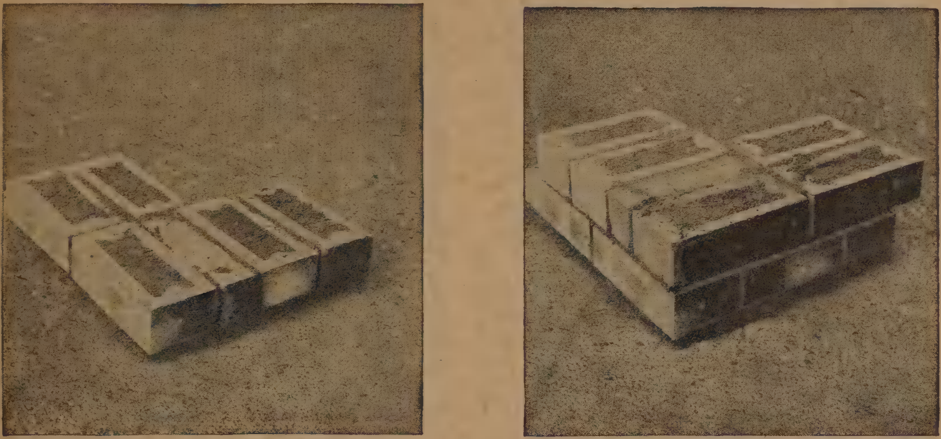


Fig. 27.—Two Courses at Corner of Greenhouse Walls

The frame or post should be bedded to the brickwork in the recess when it is being fixed in position.

The method of building the corners of the greenhouse will be the subject of some consideration. Fig. 27 indicates the correct method of arranging the bricks. The full-length "closer," quarter-brick (quarter the *length* of a brick) wide, introduced next to the first "header" in the course, secures the proper bonding of the brickwork. A "header" is a whole brick laid with its length at right angles to the thickness of a wall; bricks laid longitudinally are "stretchers" (see Fig. 27). Comparison of the courses D and C, in Fig. 27, will show that no two mortar joints come vertically over one another, "quarter-brick" bonding being maintained, as it should be, throughout the length of the wall. Figs. 28 and 29 show these courses actually built.

Building Pit Lights, etc.—The building of pit lights and brick bases for garden frames is well within the province of the amateur. Fig. 30 illustrates in plan and elevation the manner of carrying out such work. Up to this point, all the brickwork shown has employed the English bond—namely, alternate courses of headers and stretchers; but in this example Flemish bond is introduced, this consisting of alternate header and stretcher on the same course. The former is considered the stronger bond, and the latter the more effective in appearance. The arrangement of the bricks in both courses is very simple and straightforward, and no difficulty should be encountered. A 2¼ in. closer inserted after the first header in the first course secures perfect bond in the work (see the top and the bottom details in Fig. 30). Figs. 31 and 32 show the wall in process of building. The arrangement of the bricks to turn a corner will be easily understood from previous illustrations. The headers, stretchers and closers are again named on the diagram for easy reference.



Figs. 28 and 29.—Courses D and C of Greenhouse Wall (see Fig. 27)

When Two Walls Intersect.—The intersection of one wall with another not infrequently puzzles the amateur. An instance of two 9-in. walls joining one another at right angles is given in Fig. 35. The bond must be maintained, and at the internal angles of the junction of the walls there must be no straight joint running from bottom to top of the work. In course E a closer 2¼ in. wide is placed behind the centre face stretcher; the position of the next course is, as shown by the dotted lines, set 2¼ in. in from the edge of the centre stretcher. Photographs of the building of an intersection of this kind are presented by Figs. 33 and 34.

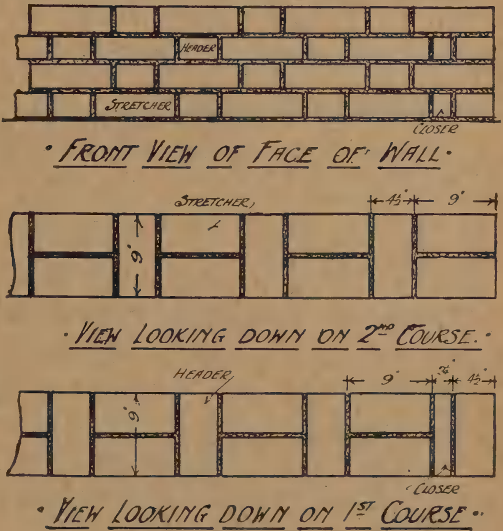
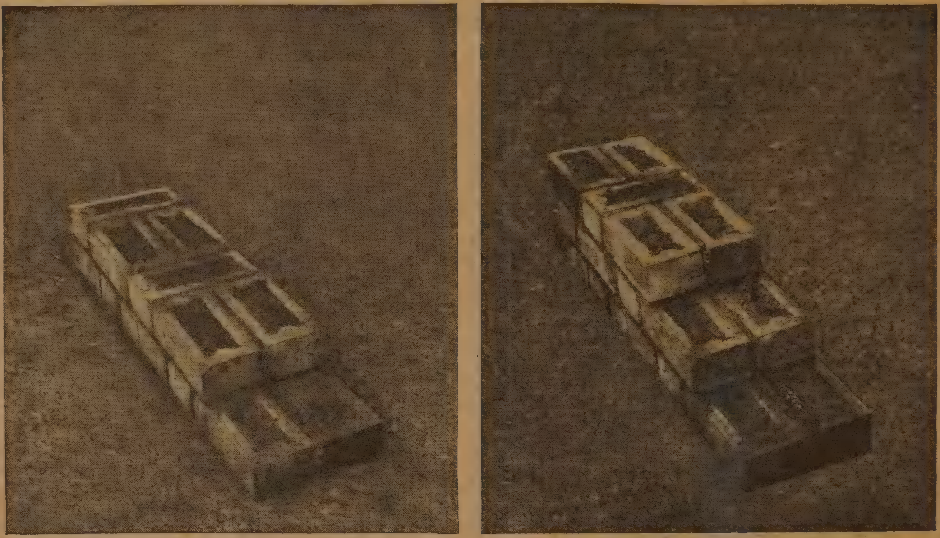

HEADER
STRETCHER
CLOSER
FRONT VIEW OF FACE OF WALL
STRETCHER
4½"
9"
9"
VIEW LOOKING DOWN ON 2ND COURSE
HEADER
9"
4½"
9"
CLOSER
VIEW LOOKING DOWN ON 1ST COURSE

Fig. 30.—One-brick Wall in Flemish Bond

Laying the Bricks.—The laying of the bricks perfectly level and square is naturally all-important, and the smallest details should have close attention. The first course on the foundation should be accurately levelled with the aid of a



Figs. 31 and 32.—Wall in Flemish Bond: First and Second Courses, over Top Course of Foundation

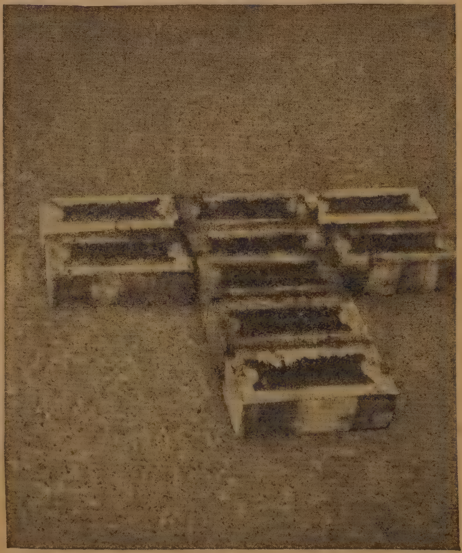


Fig. 33.—Intersecting Walls: Course E (see Fig. 35)

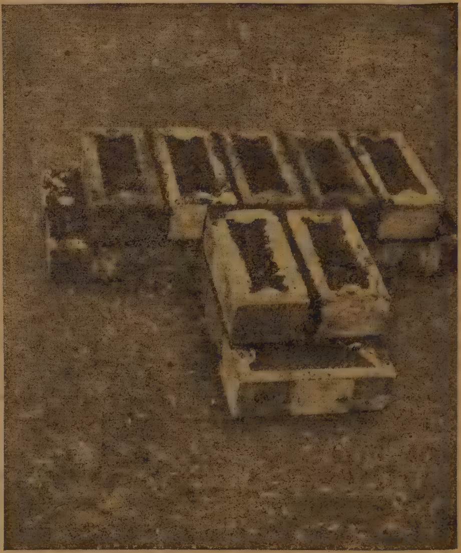


Fig. 34.—Intersecting Walls: Course F (see Fig. 35)

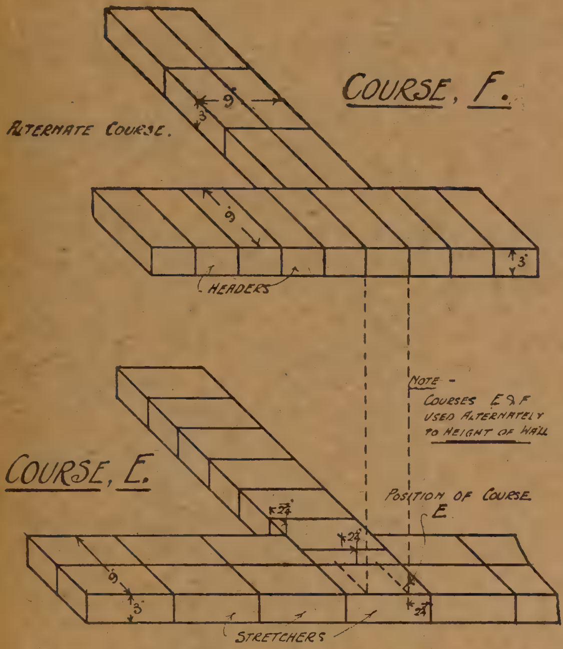


Fig. 35.—Two Courses of Intersecting Walls

straightedge and spirit-level. A little extra care taken at this point to ensure that the bed is true will save much trouble in the after stages of the work. The angles or piers at the ends of the wall are then erected to the height of about ten courses, and a line of string on bricklayers' "pins" is stretched tightly from one angle or pier to the other (see Fig. 36); substitutes for the bricklayers' pins can be easily made from pieces of hardwood tapered at the ends to pass into the joints of the wall.

A trowelful of mortar is taken and placed on the bricks already in position, spread out, and a further portion of mortar taken on the trowel and deposited, as shown at A, in Fig. 36, against the side of the brick already laid. Fig. 37 shows the next brick (previously wetted so as not to absorb too much of the moisture from the mortar) being steadied by the point of the trowel and lowered into exact position. This operation is repeated along the whole course, and then the line is raised 3 in. to the next course, and so on. The thickness of a mortar joint should be about ¼ in., so that four courses of finished brick work should measure not more than 12 in. in height, the bricks being 2¾ in. thick. As the courses are finished, the interior joints should be well flushed and filled with mortar to unite the brickwork into a solid mass. The use of a straightedge is very convenient in building short lengths of wall, when building on an old wall, and when straightening footings. The way to use the straightedge in conjunction with the trowel handle used as a hammer (which is the usual practice) is shown in Fig. 38. The straightedge should be at least 4 ft. 6 in. to 5 ft. long. The trowel handle is used as a hammer also in consolidating the work, and in squeezing the mortar joint to its proper thickness, so that the top edge of the brick is in line with the string or flush with the straightedge. Often, instead of a special straightedge, the plumb-rule (bob removed) is used, but this is not recommended as it gets very rough usage.

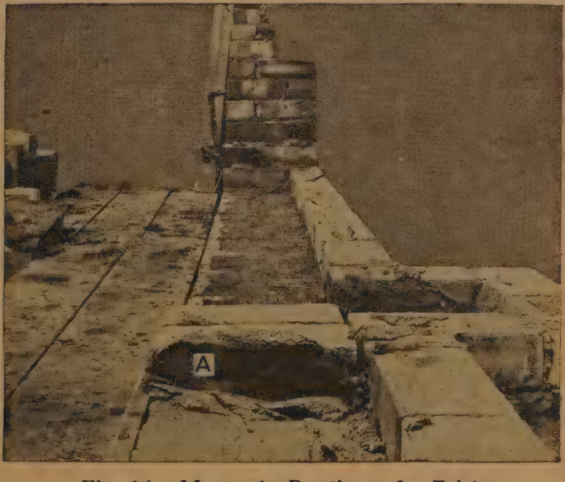


Fig. 36.—Mortar in Readiness for Brick

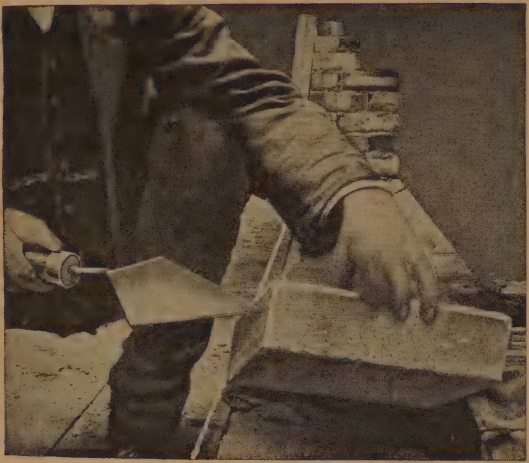


Fig. 37.—Laying a Brick

It is very important to keep the wall upright, and to ensure this a plumb-rule and bob (the plummet) is used. The plumb-rule is a 4-in. strip of floor board, $\frac{3}{4}$ in. thick and 4 ft. 6 in. long, planed true on the edges, and with a centre line

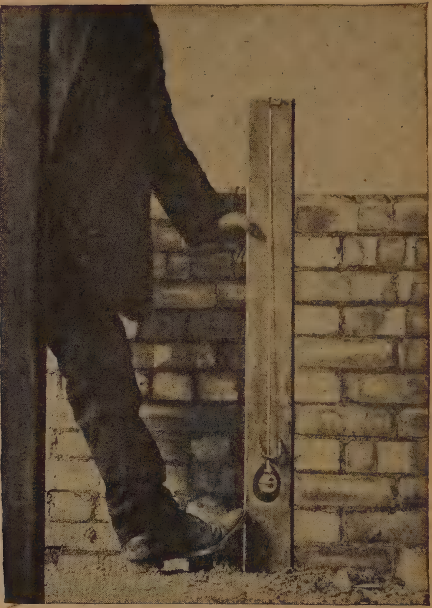


Fig. 39.—Testing Work in Course of Construction with Plumb-rule

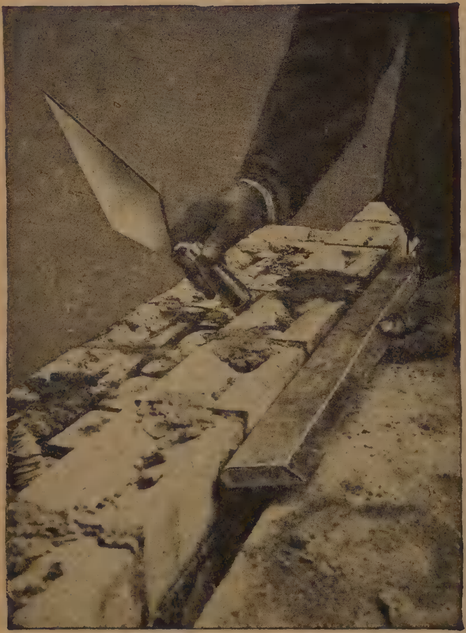


Fig. 38.—Using Straightedge in Bricklaying

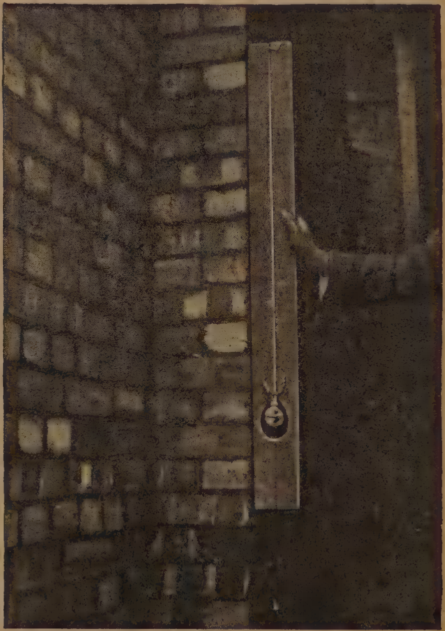


Fig. 40.—Testing Wall with Plumb-rule

marked deeply with a cutting knife for the whole of its length. A pear-shaped hole is cut at about 4 in. from the bottom, large enough for the bob to swing through freely. At the top of the plumb-rule is made a saw cut 1 in. deep, truly on the centre line, and two other cuts, one on each side of it and sloping towards it, are also made, these sloping cuts enabling the bob to be attached and removed quickly. A piece of string in a loop is fixed at the bottom just above the pear-shaped aperture to prevent the bob swinging too far or getting out of control (see Figs. 39 and 40). The bob is an egg-shaped or other suitably-shaped piece of lead or iron suspended from its top by means of a string looped at the top to pass into the sloping saw cuts. When the plumb-rule is perfectly upright, the strings hangs absolutely in front of the vertical centre line. Fig. 40 shows how the rule is applied to an existing wall, while Fig. 39 shows how it is used to test work in course of construction. Note the foot at the base, and the hand at the top. The string should coincide exactly with the cut mark on the rule. It is important to keep the joints of the alternate courses over one another, and for this purpose it is as well for the amateur to use the plumb-rule frequently or to rule with the pencil the lower course through the next to ensure the "perpends," as they are termed, being maintained.

If the wall is to be "pointed" upon completion, the joints should be deeply raked out, while the mortar is fairly soft, to receive the new pointing mortar, or if it is to be lime-whited, the joints should be worked smooth, and at a slight angle to the face of the wall with a smaller trowel.

Practical Notes on Geysers

The first and most important detail in the fixing of a geyser is the means of getting rid of the products of combustion, and more particularly the products of imperfect combustion (which nobody dare be careless with).

The necessity of a flue to a geyser lies in the fact that it burns such a large volume of gas in a short period. Quite an ordinary geyser may have a burner that consumes at the rate of 150 cub. ft. per hour, while a large one may use 4 cub. ft. per minute. As each foot of gas requires 5½ cub. ft. of air for perfect combustion, in a small unventilated room trouble should be expected if a flue is not used.

The products of perfect combustion are now known to be much less harmful than they were thought to be, but as it is never known (except by chemical analysis) whether combustion is going on quite perfectly, care should always be used. Briefly, means must be provided by which the products from the burning gas can be discharged where they will not be breathed. Care may be lessened in large or well-ventilated rooms, though at all times the products from a geyser are better outside the room than in it.

The flue from a geyser is a sheet-metal pipe. If there is a brick chimney, with a normal up-draught in it, anywhere available—in the room, in the wall from a room below, in an adjacent room or a room above—then this is the best of all places to take the metal flue pipe to. Trouble and expense are well incurred to get a brick chimney if any way possible.

The next best thing is to carry up the metal flue pipe to discharge it into a roof space. A roof may have draughts in it, but as a rule they do not cause down-blow in a flue which discharges there, provided the end of the flue pipe is in mid-air, so to speak, and away from where the wind may enter violently. Should there be likelihood of down-blow, then a "baffler" can be used.

It must never be forgotten that one of the products of combustion of burning coal-gas is water vapour (about 1 pint of water to each 27 ft. of gas burned, if all the vapour were condensed), therefore the gases from the flue pipe should not beat upon cold slates or ironwork, otherwise there will be condensation and a dripping of water on to the ceiling beneath. On this account a conical cap is usually put on the pipe end; it acts as a spreader.

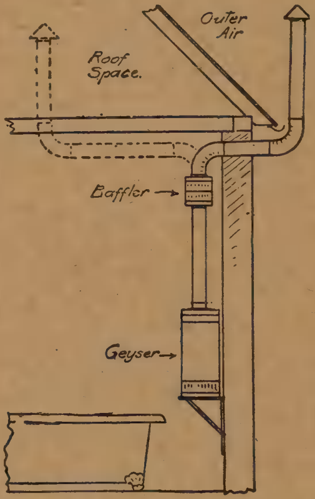


Fig. 1.—Baffler in Geyser Flue

When the only recourse is to carry the flue pipe from the geyser through the wall to the outside air, then the question arises whether it can be carried up high enough to ensure its not having down-blow occur in it. To be sure of this, the flue would, in the usual way, have to be carried up as high as the brick chimneys, this being about 6 ft. above the highest ridge of the roof. This is almost always impossible, and, if the pipe is carried up outside the wall, it generally ends just above the eaves as illustrated. The conical cap on the upper end of the pipe serves to prevent down-blow a little, but its chief purpose is to keep the rain out, while to break the force of the down-blow, the "baffler" is introduced. Its action is illustrated by Fig. 2.

The other special points in geyser fixing are: (1) The gas pipe should be $\frac{3}{4}$-in. internal diameter, remembering that the gas has to come through it in large volume in a brief time. It is often necessary to run this service from the meter. The meter should be a 10-light or 15-light, according to size of geyser, or suitably larger if other heaters and lights are served from it.

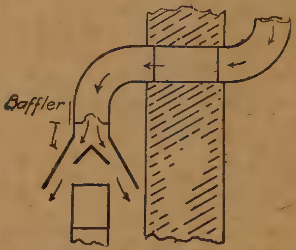


Fig. 2.—Diagram of Baffler

(2) Frequently a condense-water pipe has to be provided to take away the condensed water vapour of combustion, which must appear when gas is devoted to heating cold surfaces. The makers' directions mention this.

(3) Always run cold water through a newly-fixed geyser for a little time before trying it with heat, as there may be empty spaces to be filled, these never afterwards being empty if the geyser is regularly used.

Renovating a Grandfather Clock

THERE is, perhaps, no article of furniture so much reminiscent of bygone times as the grandfather clock. The old makers loved to put fine cabinet work into the cases, and the movements also are remarkably good, as a rule, even after a hundred years' use. There are a great many of these clocks about in all classes of homes, but it is the exception to find two alike.

Considering their age however, it is not surprising that there are so many in need of repair and restoration. Fig. 1 is a photograph of a clock which is in a very critical condition, though it does not appear so bad. The case is very shaky, especially at the foot, and it has been fixed to the wall with screws through the back. The front foot panel is badly split in three places, and the plinth is missing (see Fig. 2). The panel is of figured oak inlaid with a cross-banding of mahogany, of which there are two bits missing from the bottom line and the curved corner (see Fig. 3).

The polish is very much scratched, and the surface of the wood just beneath the polish being faded, the "figure" and colour of the two woods do not show up with their original contrast; but this can be restored by scraping and re-polishing.

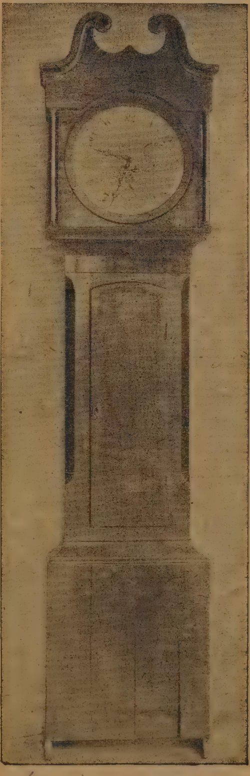


Fig. 1.—Grandfather Clock to be Repaired

The brasswork, consisting of hinges, keyhole plate, bases and caps of the two head pillars, the pair of plate hinges and small knob of the glazed door, and the terminals of the scrolls, require to be cleaned and re-lacquered. The chief centre ornament is missing and the dial requires restoring (see Fig. 4).

The first thing to do is to take out the clock weights and pendulum, lift down the head of the case, and then lift out the movement, which may be put aside in a safe place for the time being. The brasswork is next taken off, and all loose parts of the woodwork removed; the case is then well washed with soda and water, which should be well rinsed off with clean water, and put to dry, being now in the condition shown by Figs. 7 and 14 (p. 246). The head of the clock is shown with one of the scroll mouldings taken off, as it was loose; also, it is broken, as Fig. 5 shows at A, and just below it

Fig. 2.—Damaged Front of Lower Part of Case

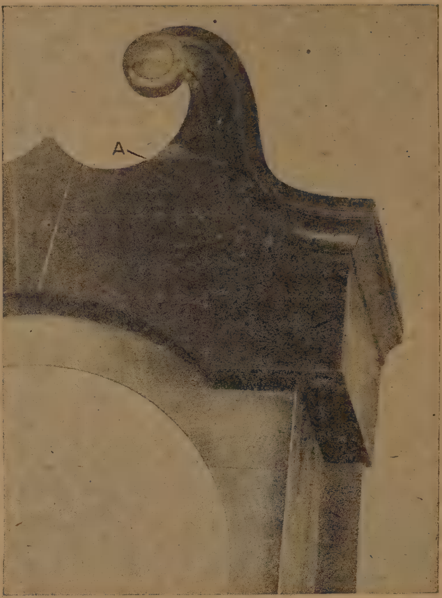


Fig. 5.—Detail of Clock Head Showing Damage

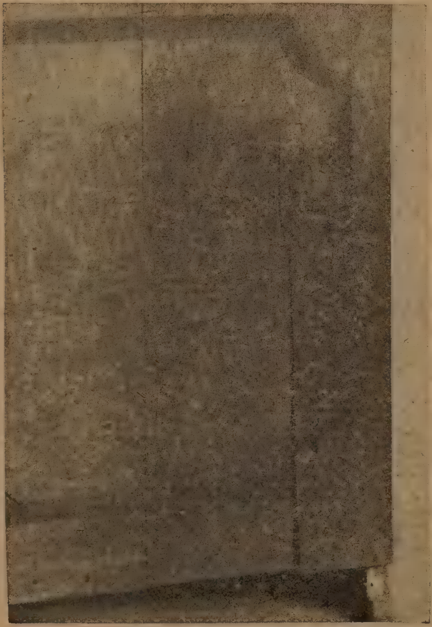


Fig. 3.—Lower Corner of Clock Case

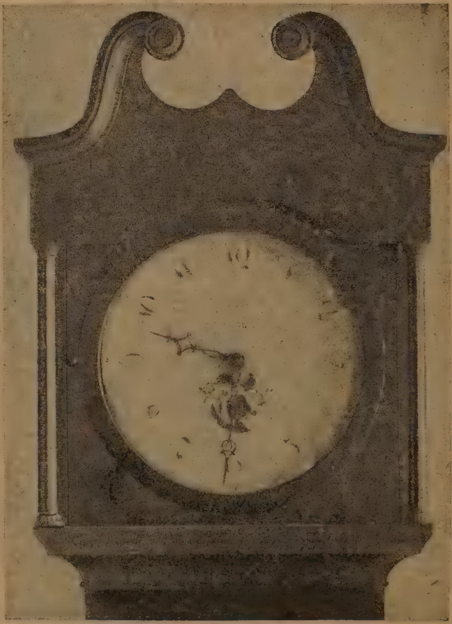


Fig. 4.—Clock Dial, etc., to be Restored

the wood is split. The split is repaired first by running hot glue between and pressing close, fixing with sprigs and glue-blocking behind. The scroll moulding with the other piece on is next glued in place and secured with a few fine pins (see Fig. 8). Where the bit is knocked out the wood requires piecing. It is mahogany, $\frac{3}{8}$ in. in thickness, and is cut out in the dovetail manner shown by Fig. 9, about $\frac{1}{8}$ in. deep. A bit of old mahogany, selected to match, is neatly fitted in and glued, to be trimmed down when set, as in Fig. 10.

The mahogany is inlaid at the centre with two satinwood lines, also on the corners of the lower and the vertical edges, and one of the latter is broken out (see Fig. 11).

The place is scraped clean with the corner of a small chisel; then fresh glue is run in and a new line glued and pressed in close; a strip of tough paper is put over to keep it down, as in Fig. 12, and this is trimmed off when set, as in Fig. 13. That is all the repair work required to the clock case head, so it is put aside to get on with the carcass.

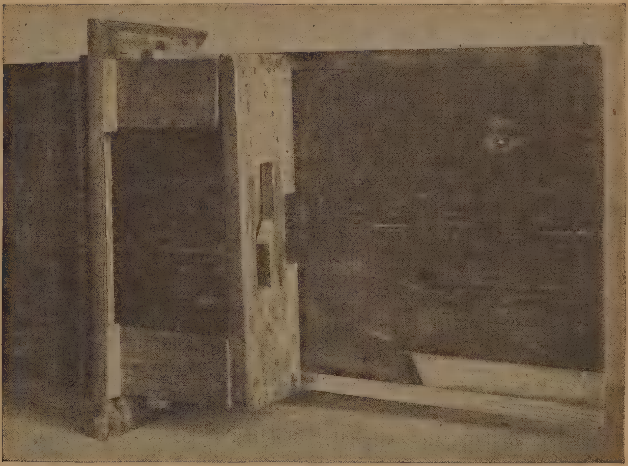


Fig. 6.—Upper Part of Case Repaired

It will be seen from Fig. 7 that the upper part of the back board has a long split, and a piece is broken and missing from the side edge. This is repaired, as shown in Fig. 6, the two pieces of deal being glued and sprigged on. Glue is run between the split, and it is pressed together and fixed with fine pins inserted across, both ways, as shown by Fig. 15; then a piece of thin board, about 6 in. wide, is glued right across at the back and fixed with a few fine sprigs. In Fig. 6 is also seen the curved oak moulding which supports the clock head, fixed back in place as before and "glue-blocked." The mitred corners are slightly damaged and split where attempts have been made at mending with nails (see Fig. 16); they need to be cut away, as shown by Fig. 17, and little bits of oak neatly fitted and glued in. They should be left a little full on the outside in thickness and width, so that they may be trimmed down when set, as in Fig. 18.

The lower part of the carcass is next taken in hand. Of the various parts, shown in Fig. 14, it is found that there are three pieces which can be dispensed with, as they are the remnants of an inefficient attempt at repairing; they are indicated at X in the photograph. The front moulding, A, is damaged at one corner, as in Fig. 19; it should be chiselled off slant to get a straight surface for splicing on a piece, as shown by Fig. 20, to be trimmed off when set, as in Fig. 21. A section of the moulding is shown by Fig. 22. The side moulding, B (Fig. 14), has a piece missing off the top edge at the back end, as in Fig. 23, the finished repair to this being shown by Fig. 24. When all these are ready they are fixed in place. The piece C (Fig. 14) is part of the back with a glued-block on it. It is fixed back in place by gluing and nailing to the edge of the deal back; then the side panel D can be fixed back, and two more blocks glued at the corner. The other side panel, E, has the slip of deal back attached to it, and when it is fixed in place a batten is put across the back to strengthen it, as seen in Fig. 25,

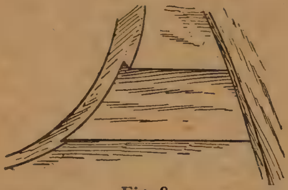


Fig. 9

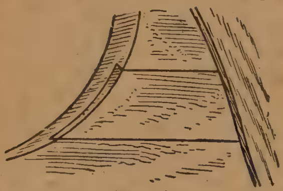
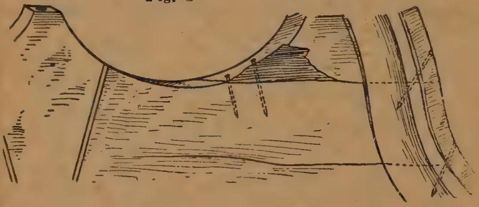


Fig. 10

Figs. 8 to 10.—Details of Repairs to Head of Clock

Fig. 8



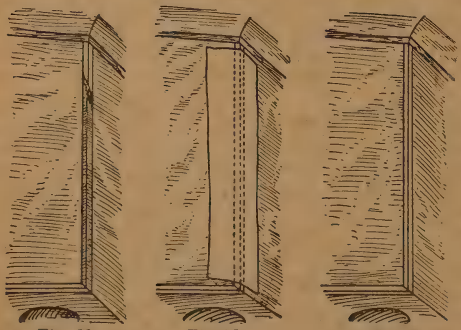


Fig. 11 Fig 12 Fig. 13

Figs. 11 to 13.—Inserting Satinwood Line in Corner of Case

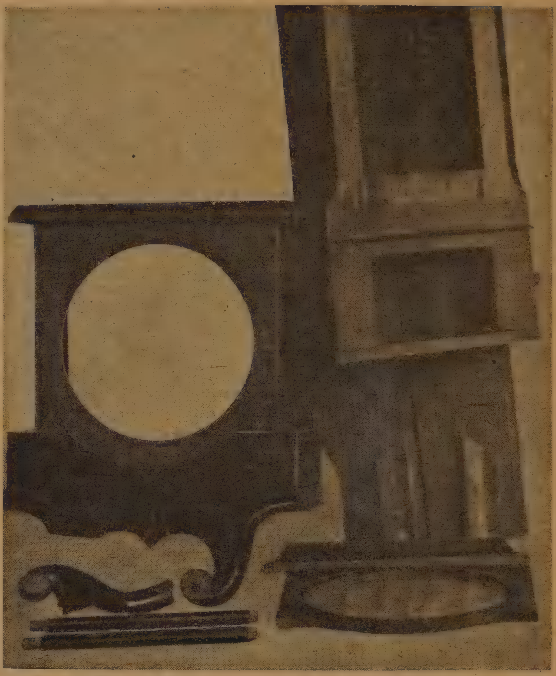


Fig. 7.—Upper Part of Clock Case

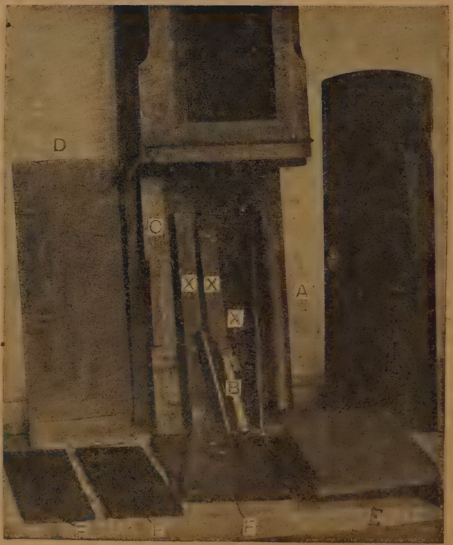


Fig. 14.—Lower Part of Case and Loose Pieces

which also shows the blocks that have still kept their position. It is then ready for the front panel, which is in three pieces marked F (Fig. 14).

Originally the panel has been made in four pieces jointed together. Therefore there are three joints, one of which has broken to about half way up from the lower edge, as seen in Figs. 2 and 3. The edges of this should be lightly scraped clean, then glued and carefully cramped close, being secured with two or three fine pins, as in Fig. 15, and one at the lower edge.

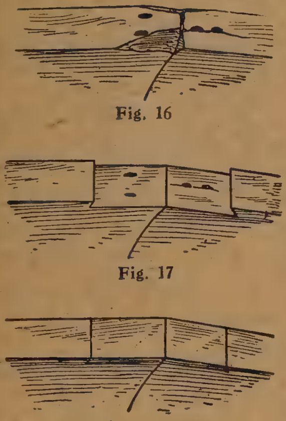


Fig. 16

Fig. 17

Fig. 18

Figs. 16 to 18.—Details of Repair to Damaged Corner of Curved Moulding

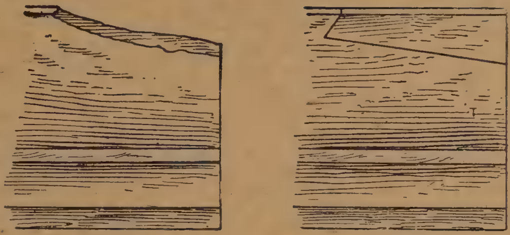


Fig. 23

Fig. 24

Figs. 23 and 24.—Details of Repair to Upper Back Corner of Side Moulding

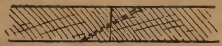


Fig. 15.—Glued Crack in Back of Case Further Secured with Sprigs

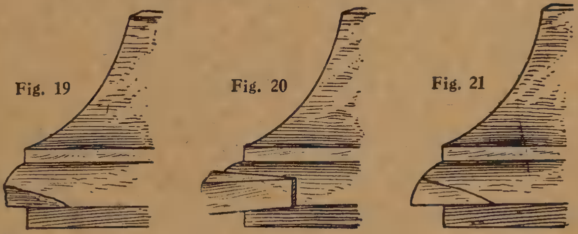


Fig. 19

Fig. 20

Fig. 21

Figs. 19 to 21.—Details of Repair to Damaged Corner of Front Moulding

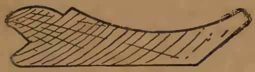


Fig. 22.—Section of Front Moulding

In re-jointing the panel, care is taken to avoid making it any narrower. Fortunately, it happens that the joint edges require very little planing to make them fit, and the work is done with an iron smoothing plane set to take off a very fine shaving. The plane is a "Stanley," and can be recommended as a very useful and inexpensive tool for the amateur woodworker for fine work (see Fig. 26). It is used in this case as shown in Fig. 27. The edges to be joined are planed straight and square so that when placed together the joint cannot be seen. But, owing to the boards being a bit warped in the length, the joint does not come even on the surface. In view of this, three or four small bits of wood are put ready to hand, about 3 in. long by 1 in. wide, by ¼ in. thick, with a ½-in. screw through near the centre. When the four joint edges are ready and each joint marked, they are well warmed for gluing. The glue is quite hot and should run from the brush like thin golden syrup. One of the joint pieces is placed in the bench vice and the other held against it with the edges even, and both are glued at the same time, being then rubbed together for a few seconds to work out the surplus glue, stopping in the exact position, as in Fig. 28. Each end of the joint is fixed with a fine pin (see Fig. 29), this being drawn out when set; then, as quickly as possible before the glue starts to set, the bits are screwed on at the back where required so as to pull the surface straight, as in Figs. 30 and 31. The other joint is glued immediately in the same way (see Figs. 32 and 33). But particular care must be exercised to avoid disturbing the other freshly-made joint; an inexperienced worker might do well to allow one joint to set before gluing the other, and even professional workmen often find it necessary to do so.

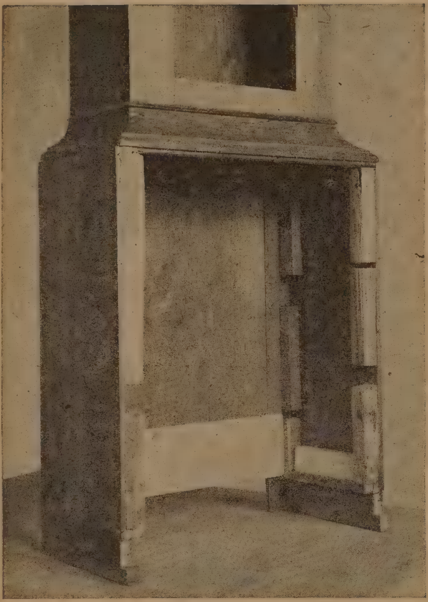


Fig. 25.—Lower Part of Case in Course of Repair

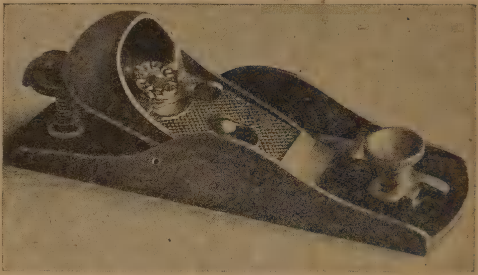


Fig. 26.—An Inexpensive Smoothing Plane Recommended for Jointing

In Figs. 2 and 3 there will be observed two places where bits of the mahogany cross-banding inlay are missing at the broken joints. It is desirable to make these good before leaving the repaired panel over-night to set, ready for cleaning up next morning. This, too, is managed by very careful handling, first the inlay being "sounded" to find any further pieces that might require raising and regluing. This is done by tapping with the finger-nail in the manner shown by Fig. 34, this being an easy way to detect any loose bits. The cross-banding is about $\frac{1}{10}$ in. thick. To let in a new bit at the curved corner, the broken edge is trimmed straight and slightly bevelled, as at G, Fig. 35; then a paper "rubbing" is taken of the shape required and cut out with the point of a knife. The new bit

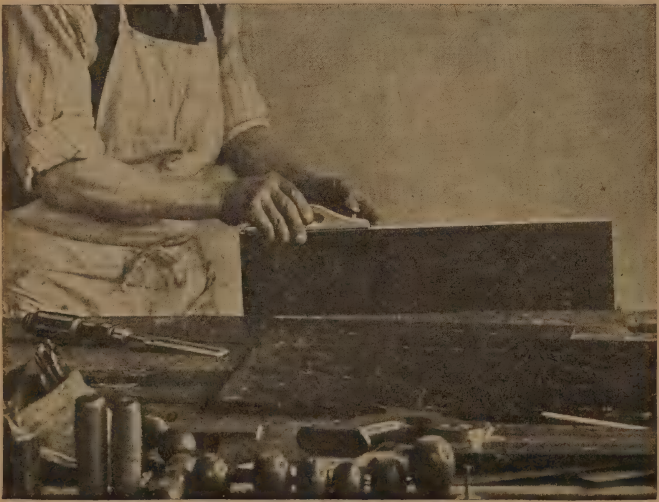


Fig. 27.—Planing the Edges to be Joined

is cut to this pattern and neatly fitted in and glued.

When the panel is set the straightening pieces may be unscrewed from the back, and the panel is then glued in place and secured with fine pins.

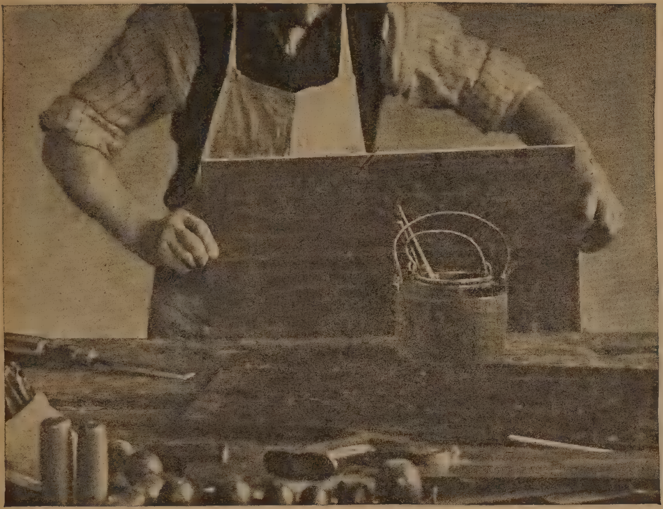


Fig. 28.—Making the Glued "Rubbed" Joint

A plinth is next to be fitted. This should be made in oak, ½ in. thick, to the pattern shown by Fig. 36, but without the mahogany moulding, and to the section shown in Fig. 37; the moulding is put on after the plinth is fixed. The two short side plinths are marked from the end of the front one, and before fixing these it is necessary to cut out the deal at the foot end of the side panels to the same shape. The front plinth is first fixed with ¾-in. screws through the panel, the ends being cut to a mitre, and then it is taken off to be put on with glue; also, in addition to the screws, pins are carefully inserted through the short grain parts into the end panels, which have to be made level by gluing in bits of deal. The short plinths are mitred to fit, well

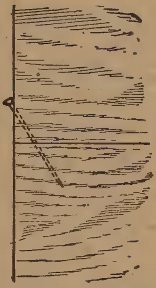


Fig. 29.—Sprig to Hold Glued Joint Temporarily

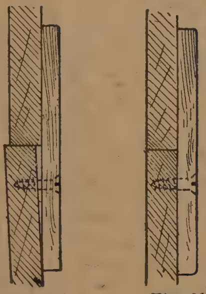


Fig. 30 Fig. 31

Figs. 30 and 31.—Method of Straightening Jointed Panel

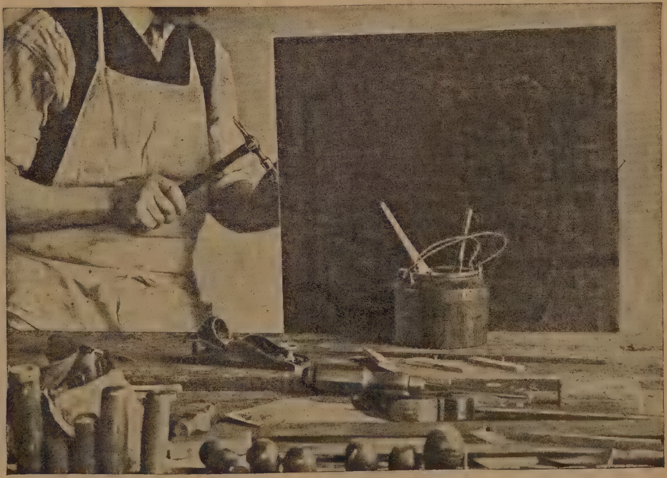


Fig. 32.—Sprigging a Glued Joint

glued in position and secured with fine pins, a couple being also inserted through the mitres at the lower corner, as in Fig. 38, and it is a good thing to hammer the glued mitres at the sharp corner to close them up well and to give a little roundness. The same applies to all sharp corners in adding new parts to old work; but in most cases it is more convenient to rub them down with glasspaper, as is the case with the edges and corners of the new plinth. When the moulding is fixed on, and a deal bottom nailed in to keep out the dust, the repair work is complete.

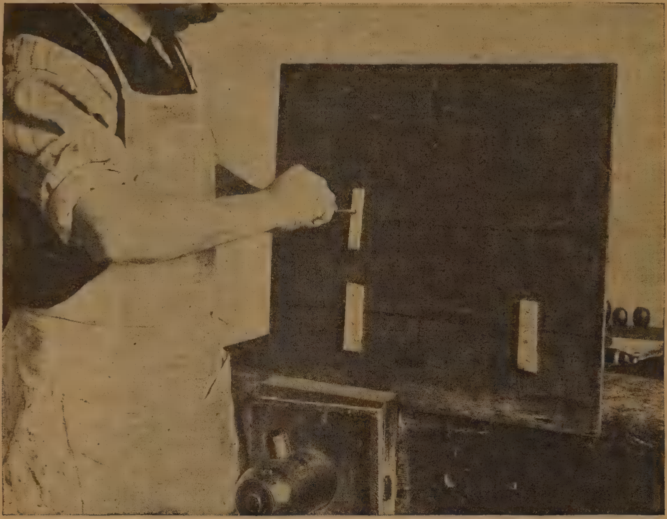


Fig. 33.—Screwing Straightening Slips on Panel

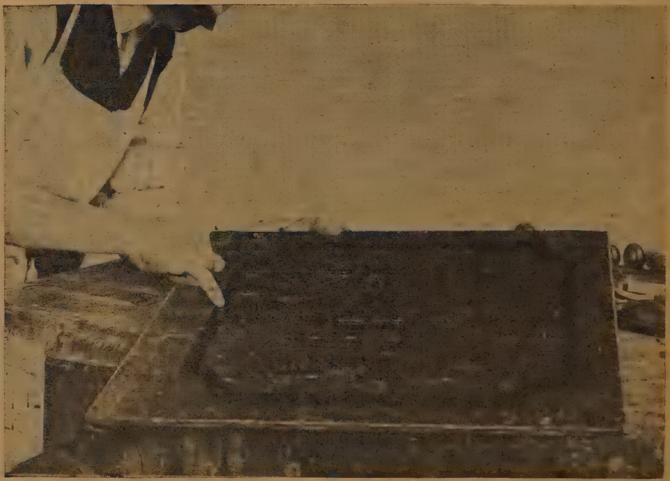


Fig. 34.—Testing Inlay for Loose Places

All the woodwork is then ready to be cleaned up for polishing. The first thing to do now is to sharpen the two steel scrapers, as described in a later chapter, in which chapter is illustrated the method of using the scrapers on the clock-case. One of the scrapers is of the usual oblong shape, as bought, and the other is made from a piece of old saw-blade and has its corners rounded for scraping the hollow parts of mouldings. When the scraping is done the woodwork is well cleaned up with No. 2 and No. 1 glasspaper (see Fig. 39).

All fine pins or sprigs should be punched down a little below the surface and the holes filled with putty, coloured to match the oak with brown umber, and to match the mahogany with venetian red. When the case is thoroughly cleaned up it has much the appearance shown by Fig. 40. The new oak in the plinth is next stained to match the old with a solution of vandyke brown in soda and water; the new deal in the bottom and the repaired back are treated in the same way. The new mahogany moulding and bits let in are darkened with bichromate of potash in water. When dry, those parts that were stained require a little smoothing with fine glasspaper, owing to the grain having been raised by the stain, and then the whole case is rubbed over with raw linseed oil applied with a soft rag. This darkens the wood and brings out the beauty of the grain (see Fig. 40), and it also increases the contrast of colour between the different woods. The case is now ready for polishing, but, to save time and polish, it is just as well first to fill in the grain. For this purpose a paste grain-filler is made for the oak by mixing a little umber with whiting and adding turpentine and a little linseed oil to give it the consistency of thick paint; for the mahogany use rose-pink instead of the umber. The filler is rubbed well into the grain with a rag, left for about an hour, and then cleaned off with fresh rags by rubbing, mostly across the grain.

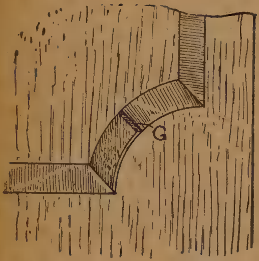


Fig. 35.—Repairing Inlay in Panel

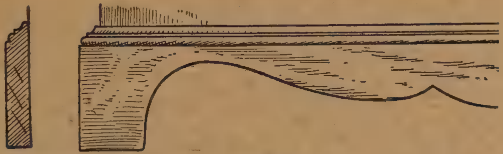


Fig. 37

Fig. 36

Figs. 36 and 37.—New Plinth, with Moulding

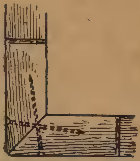


Fig. 38.—Mitred Plinth Sprigged at Corner

Fig. 39.—Using Glasspaper on Clock Case

The work is next french-polished in the usual way, using ordinary brown polish, but without either varnish or glaze, and avoiding an over-bright finish or a thick body of polish. The work is finished off with half polish and half spirits, leaving a clean, smooth, thinly polished surface, with the pores of the mahogany quite filled, but those of the oak showing slightly.

The case is left a few days to get quite hard before being fitted up, then the brass fittings are put on and a new spire ornament. The old lock on the door is out of order, but it is of very simple construction and is easily repaired. It is shown by Fig. 41 in working order. The dotted lines represent the outer part of the case, which is removed by prising off with a small screwdriver, to take out the bolt H, this being the only working member of the lock, combining bolt, lever, and spring in one. The spring part I has lost its springiness, so that the bolt slips about loosely. The only thing to do is carefully to bend the spring more open, to fit a small key, and give the lock a touch of oil. This saves the trouble of getting a new lock to the correct size or of altering the position of the keyhole in the frame.

The case is now ready to receive the "movement" which happens to be in going order, but it does not strike, and the dial requires restoring. By observing Fig. 4 (p. 244) it will be seen that the figures, name, and painted floral decoration are almost worn off. The minute divisions have disappeared, and the face enamel is much cracked and requires cleaning. Before doing this, however, the movement (that is, the "works") is examined to find out why it does not strike. (In another chapter, the cleaning and adjustment of a grandfather clock movement will be fully explained; for the present, only just sufficient information for the completion of the job in hand will be given.)

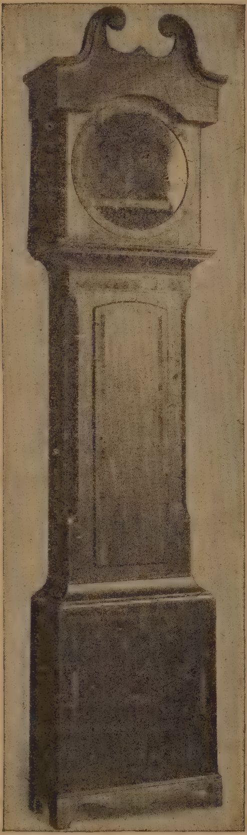


Fig. 40.—Clock Case Ready for Polishing

By moving the minute hand slowly round to the striking point and watching the wheels at the back of the dial, it is found that a pin in one of the wheels should move a lever to actuate the striking mechanism, but it is bent and passes without effecting its purpose. This may have been done by someone putting back the hands past the figure XII.

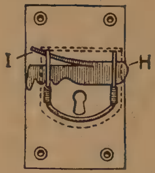


Fig. 41.—Interior of Lock

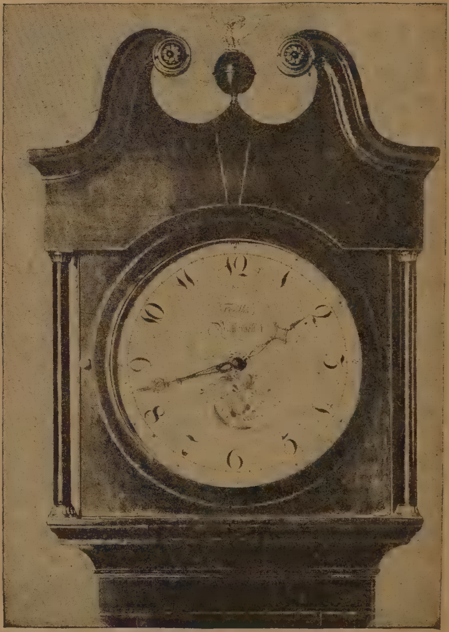


Fig. 42.—Restored Dial in Finished Head

It is a simple matter to pull out the pin, take off the hands, and remove three pins at the back to detach the dial from the movement. Then the wheel is taken off; but in attempting to straighten the pin it is liable to break off. Should this happen, the bit is punched out of the wheel and a new pin, made from a wire nail, is inserted. This is quite satisfactory; but, on being tried, at XII it strikes 13, at VII it strikes 9, and so on. To ascertain the cause, a large wheel at the back of the movement, with a number of short pins in it regulating the number of strikes, is carefully watched while the striking is set in progress. It is found that by bending these pins very slightly to one side or the other, and sometimes a shade higher, the striking may be regulated to perfection. The strike, however, is thought to be louder than is desirable and the wire arm of the hammer is found to strike against the pin at the corner of the plates, making an unpleasant knocking sound. A bit of soft rubber attached to the pin will effectually stop the noise and soften the strike to the desired tone.

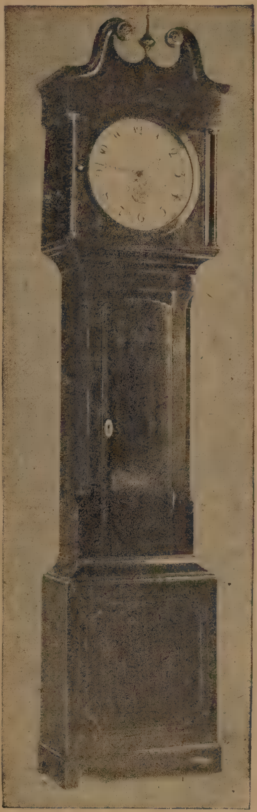


Fig. 43.—The Restored Clock, Complete

The works are very dusty and dirty. To clean them they are stood upon an ordinary 2-lb. jar with the chains inside and well syringed with paraffin oil, and allowed to drain for several days. If they could be cleaned with petrol instead, time would be saved, but the work should be done in the open air. The works are rubbed with a soft rag and slightly oiled at all working points with machine oil thinned with paraffin, or, better still, with proper clock oil.

In the meantime the dial is renovated. First it is carefully washed over with warm water and soap, then with pure water, and dried. This removes the cracked appearance. By laying it flat in a suitable light and glancing slantwise at it, the faint tracing of the figures, name, etc., may be seen. These are re-written in french-polish stained with aniline black, using an artist's camel-hair pencil of first-class quality, and the painting re-done in good oil colours, care being taken to avoid an appearance of newness. The writing, of course, dries very quickly, but the painting may take a few days.

The hands are cleaned up with emery cloth and put on, the finished clock head being shown by Fig. 42. The "eagle" ornament there shown is a regular thing with grandfather clocks, and it is merely a matter of taste whether that or the spire ornament is used, the latter being shown in the photograph of the completely finished clock (Fig. 43).

The clock itself has a much better appearance than it is possible to indicate in these illustrations. The case is thoroughly strong and bears no evidence of having been repaired, and the clock is regulated to keep perfect time. With ordinary care it may be considered that its life has been extended by another hundred years or so. The writer has restored many more elaborate clocks, but this one has been chosen for description on account of its simplicity of design and construction.

French Polishing

French polishing is an art whereby household furniture, pianos, cabinet and interior fittings of mansions, hotels and public institutions are covered with a lac solution, the object being to give the woods a polished, mirror-like surface. By its means the beauty and figure of the various woods employed are brought out and shown to the best advantage. By painting, this beauty of Nature's handiwork is hidden, and to a great extent the cabinetmaker's skill has been wasted. If left in the natural state, they have an appearance of unfinished unsaleable goods, on which dust and finger-marks soon accumulate, unless the goods are made of plain common woods on which the scrubbing brush can be used with impunity.

As its name suggests, it is of French origin, but not very old. By some it is generally supposed to be an adaptation of a process known as Vernis Martin, which means Martin's Varnish—a fine polished varnish surface, the secrets of which are supposed to have died with the inventor. However, a first-class polished surface as seen on high-grade cabinet goods of to-day gives an equally satisfactory appearance, with as equally good wearing results. It is presumed that the Vernis Martin method has not died, but is that still followed at Markneukirchen, Saxony, where about fifteen thousand persons are daily employed in making violins, the polishing of which takes a good deal of time. Some of the best violins are polished twenty or even thirty times.

Oil - varnished Work. — Woodwork that is finished with oil varnish, as used by painters, decorators and coachbuilders, presents a vitreous film of hard gums rather garish in appearance, more or less thick according to the number of coatings that have been laid on. It may be only sufficient to form a protective coating in order to keep it clean, or may present a high-grade finish according to the skill of the operator and the number of applications, and is generally laid on over a foundation of paint, though it is sometimes used without thus showing up the figure of the woods But as oil varnish is usually slow drying, and each coating should be allowed sufficient time for it to harden—usually from twelve to twenty-four hours before the next coating is laid on—it necessarily follows that the higher grade the finish, the longer the work will be on hand, and that some time must elapse before it can be sufficiently hard to handle or use.

French - polished Work. — By the process of french polishing, the gums—of which shellac only will suffice, though other gums may be added—are held in solution in alcohol, which rapidly evaporates, so that it is possible to start and finish goods on the same day.

Unlike varnishes which are spread over the surface with a brush—oil varnish with a bristle brush, and spirit varnish with a camel-hair brush—the thinner solution of french polish is laid on by means of wadding enclosed in soft rags, and worked in and out with a circular motion. The friction thus imparted gives a slight polish or shine to it as deposited, and the more polish laid on accompanied by the friction of its application, the more the work assumes a mirror-like surface.

As already explained, it is possible to finish work the same day as started. This is not the correct method, better results being gained by taking the work in hand several times, thus allowing the solution to sink into and harden in the pores of the wood, and the spirits in which the lac has been dissolved to evaporate. A harder, thicker, and more durable film is thus secured.

Using Oil to Lubricate the Rubber.—In order to work the solution, it is necessary to use with it a small percentage of raw linseed oil as a lubricant, otherwise the friction caused by the circular movement of the wadding rubber would cause a rough, instead of a smooth surface. And the greater the skill of the operator in using only as much oil as is absolutely necessary, and in clearing it off the surface afterwards, the greater the brilliancy of his work and the longer the gloss will remain.

Clearing Away the Oils. — For the purpose of clearing out this surplus oil, it is essential that as a good body of lac becomes deposited, and no more will sink into the wood, the quantity of lac used in the wadding should be reduced. Not by reducing the quantity with which it is from time to time charged, but by charging it with less polish or lac solution, and making up for this deficiency by adding an equal quantity of clear spirits to the rubber as polish that was omitted. Then at the last, as the work becomes more glossy by reason of the friction imparted, and the fact that the rubber is practically depositing no more lac, it is possible to clear off the surplus oil, and bring up the final lustre by means of a similar rubber that is charged with spirits only. But as a rubber of this latter description is apt to be treacherous in the hands of the inexperienced, by reason of its liability to be made too wet and consequent risk of breaking up the lac surface again instead of clearing off the oil, better results are likely to be gained by using instead a swab of soft clean rag.

This method of finish not only shows up all the markings of the woods that are real, but has the advantage of allowing the woods to be enriched in colour, and inferior woods to be stained or coloured up to match the better quality woods that have been used in making the articles. Aniline and vegetable dyes that are soluble in spirits readily amalgamate with the polish. It also permits of common woods being stained first to give an appearance of choicer woods. In fact, by staining the common woods first, then using a suitable dye in the polish, the work looks so solid that it is possible for a skilled craftsman to bring it up to such a state of perfection that it oft-times baffles experienced woodworkers to tell if the goods are made of common woods, or the choicer woods which they represent.

Grain Fillers.—It necessarily follows, that as the lac solution is used rather thin to enable it to be readily worked, woods of hard, close-grain texture give least trouble to the polisher, and, other things being equal, give most satisfaction when finished. And, as will be readily seen, coarse, open-grain woods absorb a lot of polish and its attendant labour of application, unless some means is adopted of sealing up these open pores. Therefore it is necessary to use something much cheaper than polish, hence what are now called "grain fillers" are used. The commonest and mostly used one is finely crushed whiting, which, with a suitable colour pigment added to remove its whiteness, is made into a paste resembling thick paint with turpentine. Plaster-of-paris and tallow was at one time much used, but as the greasiness from the tallow was apt to ooze out when the goods were used in hot rooms, it has been discarded in favour of the many special preparations that are now sold for this purpose, most of which give a clean, hard, dry surface on which to apply the polish.

On cheap deal goods it is a common

practice to seal up the pores, and prevent undue absorption of polish, by first coating the goods with glue size and colour pigment. This is a cheap practice, but it will generally be found that goods so treated do not give such good results as those goods that are stained and grain-filled before polishing.

Brush Polish.—Brush polish simply means a thicker lac solution than can be easily spread by means of a rubber, and which is useful for application with a camel-hair brush on carved work and other irregular surfaces. But as there is no friction in its application, it must not be supposed that it will give an equally satisfactory result. Such surfaces are generally finished afterwards with a smaller and softer rubber charged with glaze, which is a solution of benzoin instead of shellac, and is not worked quite dry like the ordinary polish.

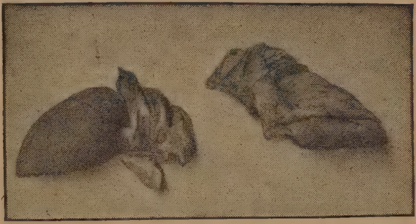


Fig. 1.—French-polisher's Rubber

For use on cheap-grade furniture or goods, the price of which will not allow the polish to be worked by means of friction right throughout, it is usual to add other gums to the lac polish solution, so converting it into a spirit varnish to be applied with a brush. This builds up a bright surface very much quicker, and by skilful management of both kinds, by sealing up the pores and forming a lac foundation, then applying spirit varnish which rapidly dries, and levelling this down with polish afterwards, a cheaper finish is secured, with the advantage that a far better resultant finish is secured than if varnish alone were used.

Making French Polish.—Two kinds of french polish are used—one, "white polish," which is nearly colourless; and "brown polish," or simply "polish." White polish is made with white or bleached shellac; the other with ordinary orange or reddish-brown shellac. Either polish may be used on any kind of wood, except where a pure tint is required. A good polish consists of about 6 oz. of shellac to each pint of methylated spirit. If too thick, add spirit; if too thin, add shellac. A rough-and-ready way of proportioning is to half fill a bottle with roughly broken shellac, and then fill up with ordinary methylated spirit. The shellac dissolves gradually, and the process is hastened by an occasional shaking or stirring with a stick. Heat is unnecessary.

Forming the Rubber.—The pad or rubber is made as follows: Take a 6-in. by 9-in. piece of sheet wadding; this will form a convenient size suitable for most work; double this, making it 6 in. by 4½ in. Squeeze this in the hand, keeping the skin of the wadding unbroken, until its shape resembles half a pear. The rubber should then be charged with polish, as described later, and covered with a piece of clean, soft rag. In folding the rag, twist it on the upper side of the rubber, avoiding creases on the working face. Further twists will bring it to a sharper point and cause the polish to ooze out on its surface. A rag covering is not really necessary on the rubbers first used. The rubber must be kept free from creases, otherwise it will cause the surface to which it is applied to be stringy or full of ridges. The rubber must be kept in good shape, not allowing it to get round, otherwise it will be impossible to get bright, clean corners. Therefore twist the rag at the point and back on the top of the rubber, keep the index finger well over the point, and press the thumb well on the side, with the surplus rag grasped in the palm.

Old rubbers are preferable to new, and when done with they should be kept in an air-tight canister or box, into which a few drops of spirit should be put now and then.

Charging the Rubber.—The covering of the rubber is opened so that a little polish can be dropped on the wadding. Have the polish in a bottle, the cork of which has a channel or notch cut in it to allow only a few drops to escape at a time. Only sufficient polish to moisten the wadding, or what will appear through the rag covering when pressed, may be used; then gather up the edges of the rag as before directed. To distribute the polish equally, press the rubber into the palm of the hand. The rubber is now ready for use.

Making the Grain Filler.—Mix some finely crushed whiting, tinted to match the wood, with turpentine to the consistency of thick paint, and well rub it in across the grain with coarse rag or tow. the work being first wiped over with oil, or first stained and then oiled. After the surface of the wood has been filled in, it should be allowed to stand for a few hours to harden. Mahogany is improved by wiping it over with red oil, which is composed of 2 oz. of alkanet root and ½ pt. of linseed oil; this brings up the figure, and imparts to the wood a peculiar tone.

With whiting fillers it is advantageous to add at least ¼ part of finest pumice powder, as this assists in grinding in and filling up the pores, besides enabling the surface to be wiped off more freely.

Use of Hard Stopping.—Beaumontage, sometimes called hard stopping, is a mixture of shellac, resin, and beeswax, but in the cheaper varieties the shellac is omitted. This composition is exceedingly useful on furniture from which little bits of veneer are chipped, or which may be otherwise bruised or blistered. It sets hard, cleans off level, and takes polish as readily as the woods; putty, on the other hand, has a tendency to shrink, and its oily nature prevents stains taking to it.

To make beaumontage, put into a tin canister or iron pot a teacupful of common orange shellac, a lump of resin the size of a large walnut, with a piece of beeswax the size of half a walnut, and for use on mahogany add a teaspoonful of venetian red; for walnut, add dry brown umber; and for oak, birch, ash, or elm, add yellow ochre. Set the vessel in the oven or on the top of a stove until the whole is melted, stir up with a stick, pour a little of the composition on a perfectly smooth board, gather it up by means of a scraper or broad knife, roll out between the hands, and while still warm roll the material into sticks between two boards by passing the uppermost board to and fro. If the loose board is kept warm in front of a fire when not in use, it gives better results. Melt the ingredients at only moderate heat, and do not let them boil, or the mixture will form into a hard mass.

To fill a small hole with beaumontage, select a stick of stopping of the proper shade. The stopping is run in and round the defect somewhat in the manner of soldering, but in place of the copper bit any piece of flat iron will do. It should not be red hot. Hold the iron in the right hand, and press the stick of stopping against it with the left hand. The composition should be run into the defect until this is well filled and a little over, and should be well pressed in while the iron is still warm. When cold, clean off level with a chisel, or knife and worn glass-paper. In a shallow bruise the stopping will hold better if a few holes are made at the lowest point with a bradawl or chisel; and if the article is veneer finish, do not have the iron so hot as to blister the material being worked upon.

Veneered work may be blistered by glowing cigars; in such a case drill in it a number of holes, run some stopping in and press down with the warm iron. When the surplus has been thoroughly cleaned off it will be found that the warmth has liquefied the glue underneath, and that the stopping holds the veneer.

The Process of French Polishing.—The usual temperature of a living room, about 70°, is that suited for polishing. If the polish chills, the room must be made warmer. If a chill is observed, gently warm the surface and it will probably disappear.

The first essential in polishing is to get a good body of polish evenly spread on the wood. Assuming that the work to be done is a small flat surface, with moderate pressure on the wadding rubber, quickly wipe over the entire surface, first with the grain of the wood, then across it. Then without delay go over it more carefully. The pressure should be gentle at first, and it should be increased as the polish gets worked in and the rubber becomes drier. But the rubbing must not become scrubbing, or this will spoil the evenness of the coat.

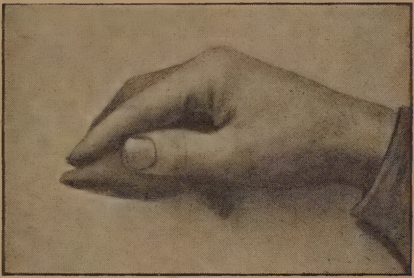


Fig. 2.—Holding the Rubber

The rubber, which is held as shown in Fig. 2, must be kept constantly in motion. It must not rest on the work during temporary absence or at the end of the day's work. As the rubber gets dry it must be recharged with polish ; but be careful not to use this in excess. Let each stroke of the rubber overlap the previous one, and avoid working in straight lines ; something resembling a circular movement is required ; but perhaps even better results are obtained by letting the motion resemble figure 8's, letter S's, and small a's (see Fig. 3).

To prevent dull corners and edges sometimes occurring keep well up in the corners and on the outside edges ; the middle will take care of itself.

Bodying means coating the wood with a thin, evenly distributed layer of the polish. When the body is too thin, the gloss that is put on may at first be beautiful, but will afterwards fade as the polish sinks or perishes. A thick body impairs the pure tone of some woods, and when the body is too thick the gloss may be all right ; but the work is apt to look treacly, as though varnish had been used.

In order that the rubber may work smoothly without sticking, the tip of a finger should be moistened with raw linseed oil and touched on the face of the rubber.

The first bodying-in process should be continued until it seems that the wood cannot absorb more polish. There will be a perceptible gloss on its surface, but it will be streaky, and the rubber marks will show very distinctly. All these marks will be removed later.

The work should stand for at least a day, carefully covered up from dust ; then on examination the body will be found to have altered in appearance to an extent which will depend on how much the polish has sunk into the wood. The work must be again bodied up as before, using as little oil as possible. It will then be again laid aside, and the bodying process repeated until the polish no longer seems to sink in, even after the work has lain for a few days. When this stage is reached the bodying may be considered complete. Fine, close-grained woods will not require so many bodyings up as the more open kinds ; but for the best and most durable work they need rarely exceed four.

Between each bodying, especially after the first and second, the surface of the work should be rubbed down with fine glasspaper, just enough to smooth the surface, but not to rub the body off. Pumice powder, used in moderation, is useful for working down inequalities of surface. It is held in a pounce bag (Fig. 4).

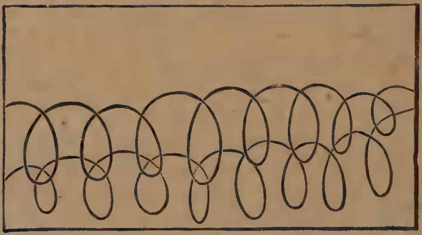


Fig. 3.—Path of the Rubber

Spiriting off is the final operation in french polishing, by which the gloss is put on the body previously applied.

Briefly, it consists in washing the bodied surface with methylated spirit. The final bodying up, or first spiriting off, consists in gradually reducing the quantity of polish in the rubber, and replacing with spirit. The polish is gradually reduced by the addition of spirit until all the polish has been worked out of the rubber. The rubber may be charged, first with three parts polish and one part spirit; next with equal quantities; the third time three parts spirit and one part polish; and the fourth charging will be with spirit only. These proportions need not be strictly observed, but this example illustrates the process. The last rubber will be almost free from polish, and it should be worked until it is dry, or nearly so.

The spiriting proper may now begin. The rubber used need not be new, but it should have been used only for spiriting, and not contain polish. It should have on its face three or four coverings of rag, and these can be removed as they dry. With only one cover the spirit is apt to evaporate too quickly. The spirit in the rubber tends to dissolve, to a very limited extent, the shellac or body on the wood. If the rubber is made too wet, there is danger of not only spiriting and smoothing the surface, but also of actually washing away the body. There should only be enough spirit to allow the surface of the body to be softened and smoothed; the rubbing should be uniform and not more in one place than in another, the less spirit there is in the rubber the better. The rubbing should be gentle at first, becoming harder as the spirit dries off; oil must not be used on the rubber face, for when there is oil either on the rubber or on the work the polish cannot be brought up. Failure in spiriting out lies chiefly in getting the spirit rubber too wet, and so softening and tearing up the gums. If the spiriting-off process is being done correctly the gloss will soon begin to appear, and when it seems approaching a finished condition the rubber should be moved in the direction of the grain only, and not across it, nor with circular motion. The final touches should be given with the soft rubber rag alone, care being taken not to scratch the surface, which is now softened by the action of the spirit. The surface will gradually harden, but for a time it should be handled with care, and nothing allowed to come in contact with it, or it is very likely to be marked. It should also be protected from dust, for any settling on it may be retained by the polish.

Glazing is very convenient occasionally, and sometimes has an advantage over spiriting, so that it may fairly be classed among the ordinary processes of polishing. The difference between spirit and glaze finishes is that in the first case the effect is produced by friction, and in the second by the addition of a thin, fine varnish to the surface of the body of polish. The real objection to glaze finish is lack of durability. Glaze may be said to be even superior to badly-spirited finish, and here is the chief claim it has for notice. Finishing by glaze is not so good as by spiriting, when the latter is well done. It should be considered as a means of getting the same effect easily and quickly—an imitation, in fact, of the real thing. Glaze is usually made by steeping 6 oz. or 8 oz. of gum benzoin to each pint of methylated spirit. When gum arabic, gum mastic, gum copal, or other tough gums are added, it is a common practice to add a quantity of powdered glass, with the object of cutting the gums when the mixture is stirred up or agitated; it forms no part of the glaze itself, and needs very careful straining to avoid getting any on the polished surface.

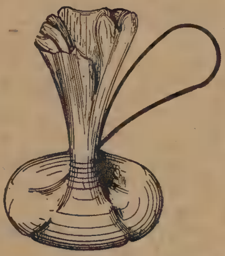


Fig. 4.—Pounce Bag Used for Sprinkling Pumice Powder

Glaze may be applied with rubber, sponge, or brush; in most cases the rubber is more suitable and is more commonly used. It is made in the ordinary way as used for polish, but it must not be applied with pressure. The glaze is painted on rather than rubbed into the work, which must have been previously bodied in. A polish can only be got on wood by varnish, or by bodying-in and polish.

The rubber for glaze should be made wetter than for polish or spirit. It should not be so wet as to drip, but it should wet the wood when the rubber is very lightly pressed on it. One or two wipes in the direction of the grain of the wood, with a somewhat quick motion, will put on the glaze. Always let the glaze dry before applying the rubber again to the same place. The coats may be repeated until the gloss is satisfactory; but the film of glaze should never be made a thick one.

Remedying Damp Walls

WHILE often the only cure for a damp wall is the insertion of a damp course or even a more drastic structural alteration, there is a number of paint and varnish preparations that may be used with advantage on the interior of buildings which are to be afterwards papered or painted. The preparation first given may also be used on the walls of stables, cellars, and outhouses, or where the painters find any difficulty in making ordinary paint adhere. Obtain 4½ lb. of zinc white paste paint, 7 lb. of pale resin, 1 pt. of oak varnish, ¾ gal. of coal-tar naphtha, and 1 qt. boiled linseed oil. Melt the resin in an old iron vessel over the fire, then add the boiled oil and varnish, and stir well together. Take the preparation well away from the fire, and allow it to cool to somewhere about 100° F.; then add the coal-tar naphtha steadily while constantly stirring. In another vessel break up the zinc paint with ¼ gal. of coal-tar naphtha; then thin down with the above preparation. The above makes an excellent white, but may be prepared of any colour by thinning down good quality paste paints and using the above preparation as a medium for mixing. If a brick-red colour is required, add venetian red or red oxide; and a good stone colour may be made by using italian ochre and zinc white. White-lead should not be used, as it does not chemically mix with the ingredients. Should the proportions be too large, reduce accordingly. Care should always be exercised in mixing the naphtha well away from any fire or light, as it gives off an inflammable vapour. This preparation dries with a hard enamel-like surface in about six hours, or, if applied warm, in three hours. The above is sufficient to cover 125 sq. yd., one coat, at a less cost than boiled oil.

Another simple preparation may be produced by dissolving 4 oz. of pure rubber in 1 gal. of boiled oil over a fire, allowing it to cool; then add sufficient solvent naphtha to thin down ready for use. This preparation may be used on both interior and exterior work, and may be used with advantage when the plaster falls or cracks. When using, it should be well rubbed into the walls until all suction is stopped, two coats being generally sufficient. It forms a tough, elastic, and binding coat. It may be coloured as desired by adding paste paints.

Dampness in newly plastered walls may be remedied by applying two coats of solution made by dissolving 2½ lb. of orange shellac and ¼ lb. of common resin in 1 gal. of methylated spirit, and after this is quite dry the plaster may be papered.

In cases where the dampness is caused by rain penetrating the wall, a remedy that is often effectual is to cover the whole of the exterior with portland cement stucco, preferably waterproofed by adding a well-known waterproofer.

Birdcages and Aviaries

In making cages and indoor aviaries, nine kinds of which are illustrated by Figs. 1 to 9, the following points should be considered: the comfort of the birds; the prevention of parasites; the adoption of such a design that will allow of the cage being easily cleaned, and the birds as easily fed.

Tools.—Cage making does not require an extensive set of tools, nearly all being those possessed by the average woodworker. When planing up very thin material, a planing board should be used, because the ordinary bench stop, being used for all kinds of work, soon loses its sharp edge, and it will then be somewhat difficult to plane thin wood. To make a planing board as shown by Fig. 10, take a wide board of hardwood, about 2 ft. long and 1 in. thick, and, after planing it up true, let in an oak stop 2 in. in from the end, so that it projects about ⅛ in. above the surface.

Wood.—The best wood to use for the tops, bottoms, and ends of cages is yellow pine or deal. If only a few cages are to be made, American whitewood would be as cheap; it is soft and easy to work, and adapts itself to staining very well. The wood must be well seasoned, for if it shrinks after being put together it will leave cracks or crevices at the joints, and thus form good harbours for parasites. When cutting up the wood, avoid as many knots as possible, but if there are any knots in the piece to be used, knock them through and plug the apertures with pieces of the same material, fixing them with glue. To give the cages a more pleasing effect, the fronts are often made of some hardwood, mahogany or walnut being preferable; another advantage of hardwood is that, when boring the holes for the wires, the wood will not so easily split.

Jointing.—The carcases of cages are usually put together with an ordinary glued butt joint, but unless the ends of the pieces can be planed perfectly true (and for this a shooting board should be used), it is advisable to rebate them, or, better still, to use dovetailing where convenient. Glue should be used in all cases to ensure closer joints. In nailing, use fine iron brads, as the heads of these can, if required, be punched in below the surface and the holes filled in with stopping.

Wire.—If the wire for the fronts is purchased in coils, and not ready cut to size and straightened, a wire straightener (Fig. 11) should be used. If only sufficient wire for one cage is required, it could be cut off in lengths and beaten straight on the bench top with a wooden mallet. To make a wire straightener, prepare a piece of hardwood about 1 ft. 6 in. long, 4 in. wide, and 2 in. thick, and at one end screw in a strong picture hook as shown. By this hook the straightener is held in position during the operation of drawing the wire, the hook being placed over a nail in the bench. Now take a piece of straight wire of the same gauge as that to be straightened, and lay it along the block of wood, and drive in the pegs

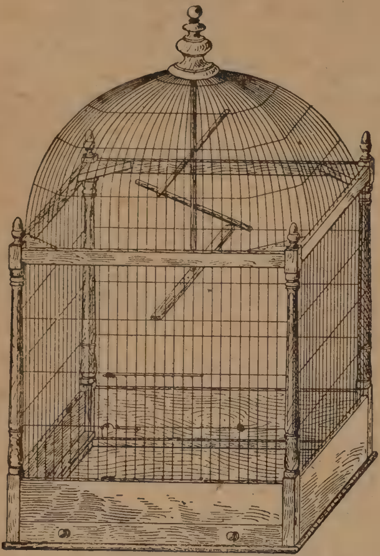


Fig. 1.—One-domed Square Aviary

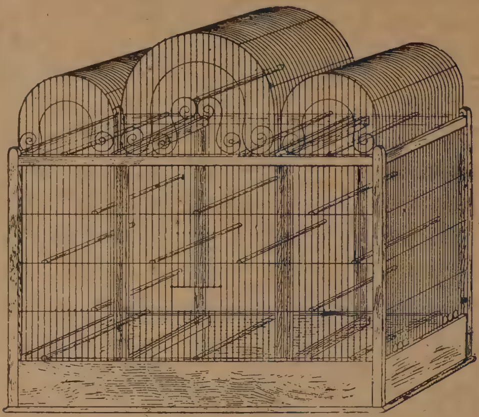


Fig. 2.—Crystal Palace Aviary

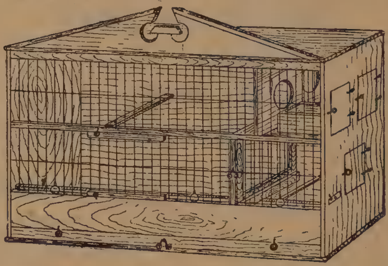


Fig. 3.—London Breeding Cage

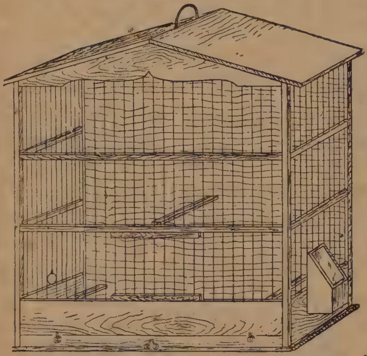


Fig. 4.—Blackbird's or Thrush's Cage

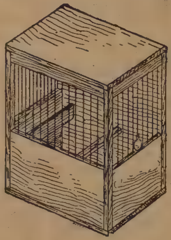


Fig. 5.—Back Cage

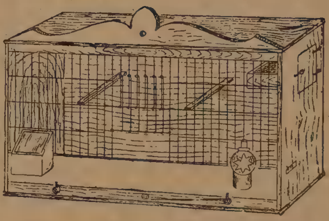


Fig. 6.—One Compartment Breeding Cage

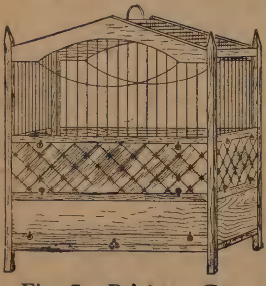


Fig. 7.—Brighton Cage

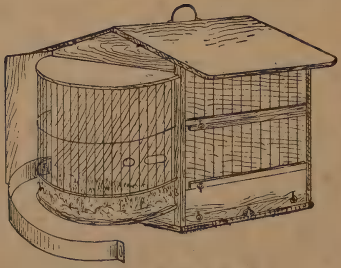


Fig. 8.—Lark's Cage

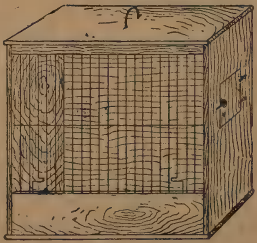


Fig. 9.—Box Cage

close up to the wire at convenient intervals as shown. The pegs should be of strong wire or wire nails, and bent to lean slightly over the wire; and to keep the latter close down to the wood, staples are fixed at A and B (Fig. 11). To straighten the wire, first pass it under the staples at A and B, and then through the pegs and out between the two end pegs at C. If the wire does not come out straight, the pegs should be slanted a little more. Generally, the pegs will be found to control the straightening of the wire, but some experience is necessary before the wire can be drawn out perfectly straight. As a number of different gauges of wire will probably be used, it will be as well to make two or three of these straighteners, though one will do for, say, Nos. 16, 17, and 18 B.W.G., and one for two or three other sizes.

The wire fronts can be made movable or fixtures. The only advantage of a movable front is that it can be entirely removed for the purpose of cleaning the inside of the cage. A movable front is usually a wooden frame wired, but the disadvantage of this is that, unless it fits close all round, parasites are likely to harbour in the crevices. In a permanent front, the ends of the wires are let into strips of wood fixed to the sides of the cage. This front is the one most used by cage manufacturers. The wires of cages for canaries, linnets, and birds of a similar size should be ½ in. apart, and for larger birds, such as larks, thrushes, blackbirds, etc., the wires should be ⅝ in. or ¾ in. apart. The best wire to use is tinned wire, and, when purchasing, care should be taken to see that it is clean and free from tarnish or spots. Avoid brass wire, as it produces verdigris, which is very injurious to the birds. The gauge used for the upright wires is No. 17 or No. 18 B.W.G., and for cross wires No. 13 or No. 14 B.W.G. will be suitable.

Boring Holes for Wires.—Before starting the wiring, the holes should be bored to receive the wires. To mark off the position of the wire holes, run a pencil line down the centre of the wood, and prick with a pair of divider compasses set to, say, ½ in. apart. If it is intended to make a number of cages, a metal template (Fig. 12) should be used. The template is placed on the bars, and the holes bored into the wood through those in the template. There are many methods of boring the holes, but the one usually adopted is with a specially prepared bradawl. With this, using a little care, the holes can be made without splitting the wood. To make a suitable awl, the point of an ordinary bradawl should be first cut off at about ⅜ in. from the handle, and the blunt end sharpened to a conical point on an oilstone. The sides are then filled right up to the handle, so that it is all of the same thickness; it should be a shade thinner than the wire to be used. When making the holes with this awl, see that it is sharp and cuts across the grain; it should be driven into the wood right up to the handle, the holes being thus of a uniform depth.

Inserting the Wire.—The wire is inserted in the holes by holding it ½ in. or so from one end in the pliers, and then pushing it into place, nothing more than the grip of the wood fibres being wanted to hold it tight. As the wires are not strong enough to stand alone, only being let into the wood at each end, they are strengthened with cross bars, one or more being used according to the size of the front. These cross bars can be of wood or wire, or they may be metal bands. If wooden cross bars are used, great care should be taken to bore the holes perfectly perpendicular. Wire cross bars can be fixed by soldering or binding them to the upright wires, but soldering, if it is done properly, will make a much stronger and neater front. To solder the wires, take a thin stick of wood, dip it in the flux (killed spirit), and put a spot on the wires where the joint is to made. Then heat the bit, dip it in the flux, and apply it to the solder, picking up a little, and join the wires. As soldering the wires is a somewhat difficult operation, they are more often bound together with thin wire known as "lapping wire," and this is a much easier and quicker operation. The two methods of binding shown in

Figs. 13 and 14, one with a single twist and the other with a double twist, not only tighten the whole of the front, but make it impossible to displace any single wire or widen the space between two wires.

Seed and Water Holes.—The wires for the holes through which the birds obtain seed and water should be a few inches longer than the other wires, and the holes should not be more than $\frac{7}{8}$ in. across for such birds as canaries. Patterns for the holes are shown in Fig. 15; the wire for A, C, and D is bent with the pliers, leaving about $\frac{1}{2}$ in. at the bottom to be inserted in the wood, and for B the wire is bent round a piece of hardwood, and afterwards twisted at the top as shown. The bottom of the loop is then hammered out flat on a piece of iron, and fits into a slot in the wood. This slot can be made with a sharp knife, but it should not be deeper than is necessary to hold the loop firm.

Turn-rail.—For cleaning out the cage, a turn-rail or false bottom or draw-board (see Figs. 16 and 17) should be used. Whichever is used should be let in at the bottom of the front or back. The simpler of the two is the turn-rail, and to make this, plane up a strip of wood to $\frac{1}{2}$ in. wide and the same thickness as the cross pieces. When made to fit so that it can be pushed in or out, put it in its place at the bottom of the front or back, turn the cage upside down, and at about 4 in. from one side pierce a hole with a bradawl through the bottom, through the piece of wood just planed, and into the cross-piece above. Then drive a piece of stout wire in the hole and the turn-rail can be pushed backwards and forwards.

False-bottom or Draw-board.—A false-bottom or draw-board is made from a piece of $\frac{1}{4}$-in. material, with a beading tacked and glued round the edge to prevent the birds scratching the sand over the edges. With a turn-rail the cage can be cleaned out by simply pushing in one end, as shown in Fig. 16, and inserting a small scraper. By using a draw-board which can be taken right out, the surface of this can perhaps be cleaned and re-sanded more easily than by scraping the bottom of the cage and throwing the sand through the wires, as would be the case with a turn-rail.

Doors.—The doors should be large enough to admit the hand easily, and should harmonise with the front of the cage. If wooden cross bars are used, the door should have a wooden frame (see Fig. 18), and for wire cross bars use either a sliding door (Fig. 19) or a metal framed door (Fig. 20). In making the wooden framed door, bore the holes for the wire only half-way through the wood, and see that the wires are in an exact line with the wires of the front. The uprights are fixed to the bottom piece with a single brad at each joint. To hinge the door, one of the wires of the front is passed through the two projecting ends as shown. These ends should be neatly rounded off, and the opposite two cut away on the inside, so as to allow the door to shut against a wire, and at the same time fit flush with the front.

The sliding door is more simple in construction, and if carefully put together is a most effective self-closing arrangement. It is made by bending eyes to the several wires with a pair of pliers, and hooking them to the wires above the cross bar so that they will run up and down freely. Then bend them at right angles, and they should be in a straight line with the other wires of the front. A piece of wire for the bottom of the door that is parallel to the cross bar is hooked to the upright wires, so that it slides up and down, and the ends of the wires just hooked are then pinched tight on to this piece. This door requires no fastening, and is perhaps the best one to use with wire cross bars, as it is impossible for the birds to open it.

In the metal framed door, the wires are soldered at the top and bottom to a thin band of metal, similar to Fig. 20. The shutting ends of these two bands are, as in the case of the wooden door, slightly cut away to make the door when closed fit flush with the front. Hinge it to the front as described for a wooden door.

Fastenings.—To fasten doors, draw-boards, turn-rails, etc., use either small wooden buttons or wire hasps as shown

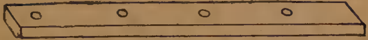


Fig. 12.—Template for Marking Holes

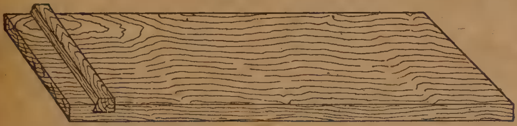


Fig. 10.—Planing Board

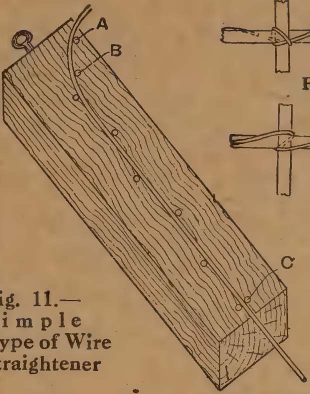


Fig. 11.—Simple Type of Wire Straightener

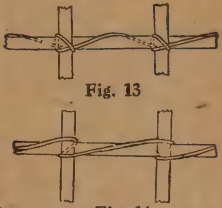


Fig. 13

Fig. 14

Figs. 13 and 14. — Two Methods of Wrapping Wires

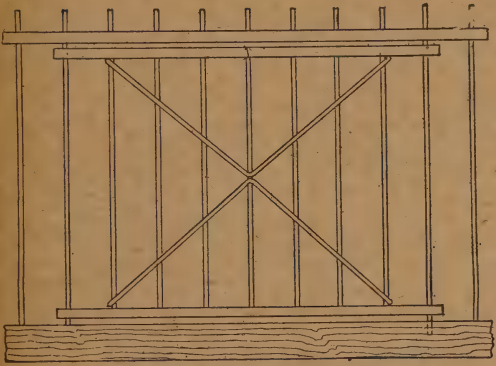


Fig. 20.—Metal Framed Door

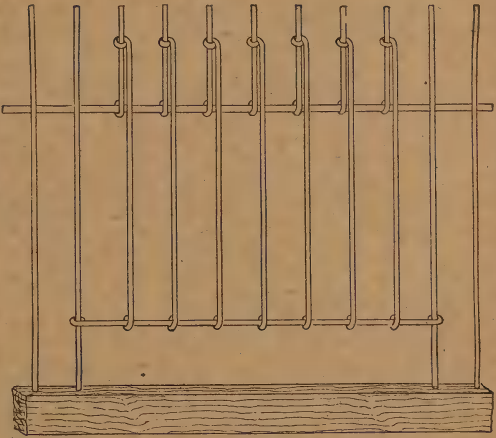


Fig. 19.—Sliding Wire Door

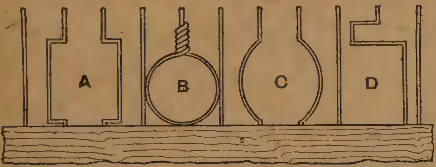


Fig. 15.—Four Patterns of Feeding Holes

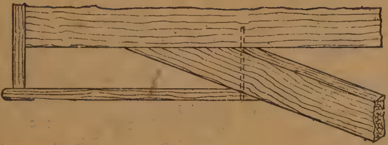


Fig. 16.—Turn-rail

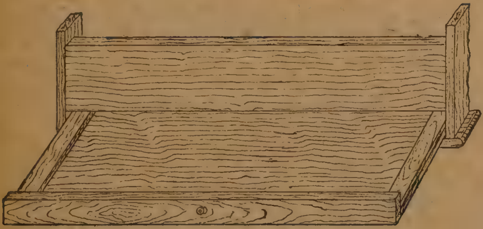


Fig. 17.—Draw-board

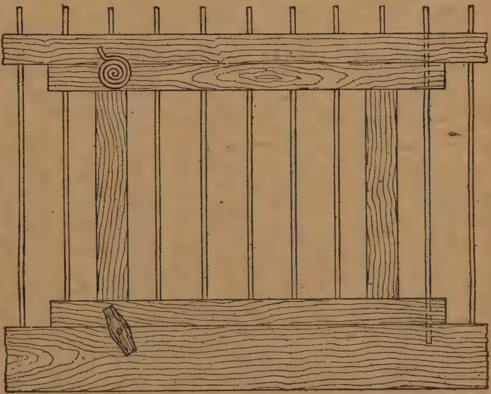


Fig. 18.—Wooden Framed Door

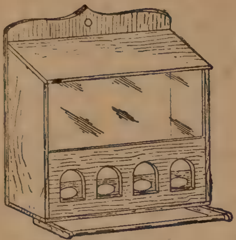


Fig. 22.—Self-feeding Seed Hopper

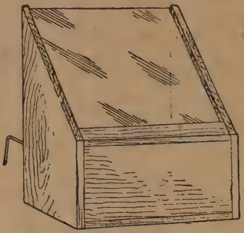


Fig. 21.—Seed Hopper

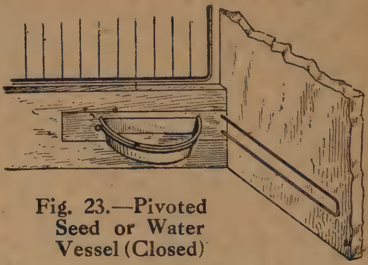


Fig. 23.—Pivoted Seed or Water Vessel (Closed)

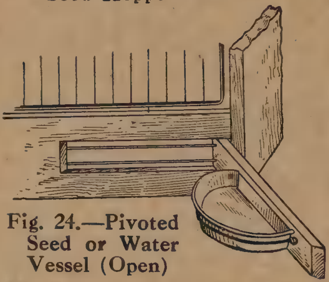


Fig. 24.—Pivoted Seed or Water Vessel (Open)

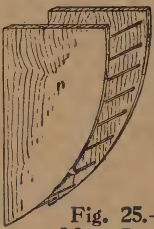


Fig. 25.—Moss Rack

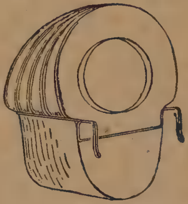


Fig. 26.—Glass Water Vessel

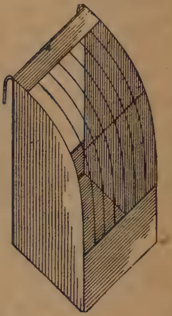


Fig. 28.—Metal Bath

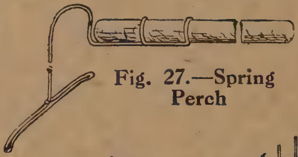


Fig. 27.—Spring Perch

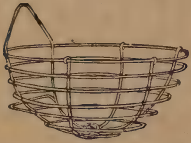


Fig. 29.—Wire Nest

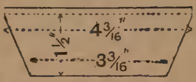


Fig. 30.—Pattern for Side of Tin Water Vessel

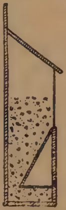


Fig. 32.—Section Through Self-feeding Hopper (see Fig. 22)

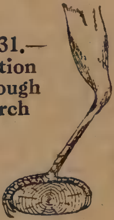


Fig. 31.—Section Through Perch

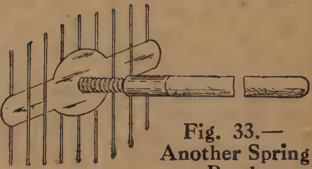


Fig. 33.—Another Spring Perch

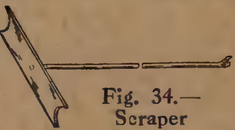


Fig. 34.—Scraper

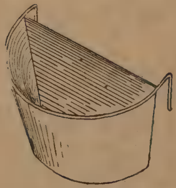


Fig. 35.—Tin Water Vessel

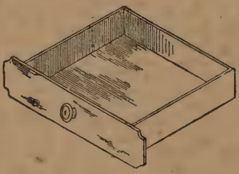


Fig. 36.—Egg Trough

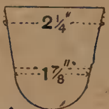


Fig. 37.—Pattern for Back of Tin Water Vessel

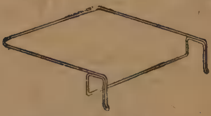


Fig. 38.—Wire Bracket for Water Vessel

in Fig. 18. The button is fixed with a small screw, and the wire hasp is made by coiling a piece of wire to the diameter of about $\frac{3}{4}$ in., inserting the projecting end into the cross-piece of the front, and turning it up at right angles inside the cage.

A number of accessories are illustrated by Figs. 21 to 38.

Colouring Cages.—The colouring of the insides and the painting, staining, and varnishing of the outsides of cages is a matter of taste, but by having a cage nicely whitewashed, stained, and varnished, it not only looks better, but adds to the beauty of the bird. The whitewashing should be done through the door, or, better still, before the cage is wired. A medium-sized paint brush should be used, with the handle shortened to 3 in. or 4 in. Some breeders, before coating a new cage, apply a thick paste of plaster-of-paris to every joint and crack so as to be sure that there are not any possible crevices for the parasites to harbour in. To whiten the inside, first give it a coat of the following preparation: Dissolve 2 oz. of glue in 1 pt. of boiling water, adding about ¼ lb. of whiting. When this is dry, glasspaper the surface smooth, and apply a coat of whitewash made by mixing whiting in glue size and water, adding a little ultramarine blue to prevent it turning yellow, and a pinch of powdered alum. For a blue finish add more ultramarine blue. In re-coating cages, first knock off any loose flakes of whiting. Many fanciers coat the insides of cages with good enamel paint.

A Sundial Pedestal in Brickwork

As a general rule, the simpler the design of a sundial the better is the effect. The pedestal has two essential parts—a shaft to carry the dial and a raised platform, the whole being bold in treatment and simple in lines. Bricks in combination with tile, or stone of warm colour, look as well as anything, and tend to give a note of cheerfulness to the immediate surroundings, which would be absent if a material cold in colour were employed.

Figs. 1 to 4 show a pedestal and base treated upon simple but effective lines, brickwork and tiles, in conjunction with a lead-dressed cap upon which the dial is fastened, being the materials used. Fig. 2 is an elevation, Fig. 3 a plan, and Fig. 4 a section. In height the pedestal should be such that a person when standing upon the platform could comfortably lean the elbows upon the top.

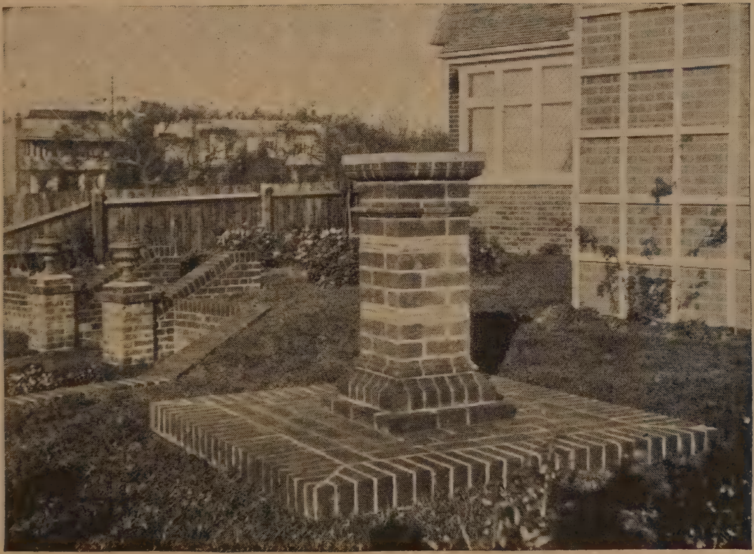
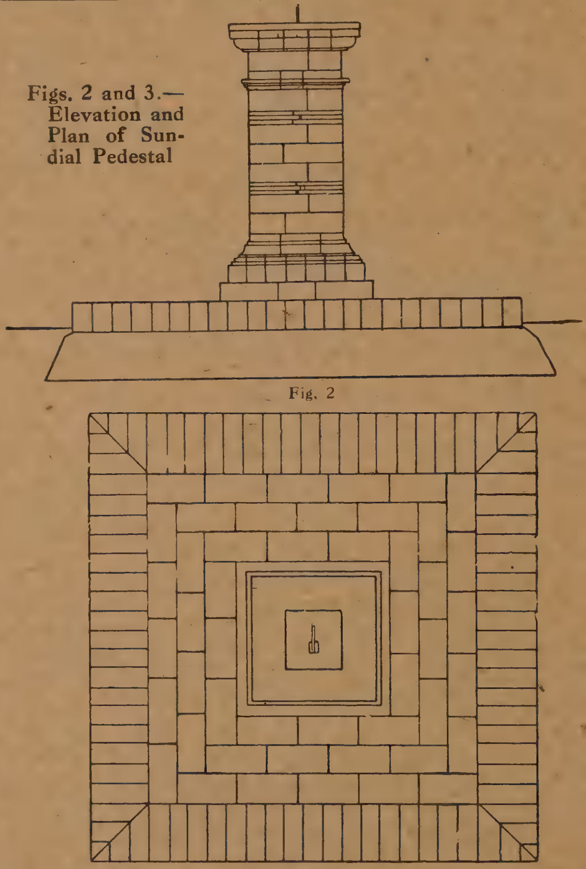


Fig. 1.—Sundial Pedestal

For the practical details of the work

the reader should refer to an earlier chapter, "Simple Bricklaying," in the present volume. The concrete foundation should be at least 6 in. thick, and should be sloped outwards, as indicated in Fig. 2. The plan clearly shows how the bricks are arranged to form the platform. The introduction of tiles with their edges showing on the face of the work has a most pleasing effect. The hand-moulding of the bricks to the sections given in Fig. 4 is outside the amateur's capabilities, but he can obtain "purpose-made" bricks—that is, bricks specially moulded in course of manufacture—but good work is possible by the use of ordinary square-edged bricks alone, with or without tiles. Thin bricks are also obtainable, and these would give an excellent effect. The table for the sundial may be a slab of stone, marble, a heavy piece of wrought oak, or, as already proposed, a sheet of lead "dressed" (hammered with a wooden mallet) over the edges of the brickwork. No amateur need feel deterred by difficulties arising from the ornamental design of the pedestal; a simple square shaft has been known to have quite a good appearance, and there is nothing in the practical work that an amateur cannot accomplish with the aid of the chapter above referred to. The brick courses for a similar pillar (but without tiles) are illustrated on p. 233 of this volume.



Figs. 2 and 3.—Elevation and Plan of Sundial Pedestal

Fig. 2

Fig. 3

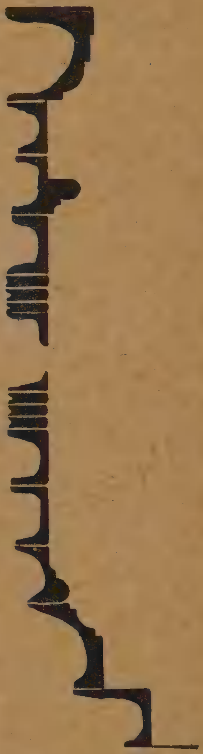


Fig. 4.—Part Vertical Section Through Pedestal

Repairing and Grinding Scissors

The Tools.—In the repairing of scissors and cutlery in general, the following tools are required: Bench-vice, either the cutler's stithy or anvil (Fig. 1) or the scissors-smith's stithy or anvil (Fig. 2), breastplate (Fig. 3), drill stick and cord (Fig. 4), drill stock (Fig. 5), drills (Fig. 6), setting hammer (Fig. 7), flat hammer, wire nippers, and files; also grindstones of various sizes (emery stones are the most convenient kind, if properly used), glazers, buff, and rag dolly or mop. The driving power may be treadle or engine. If a proper scissors stithy, with hole in it for putting-together purposes, is not available, any small anvil may be made to serve; for punching out rivets place a small iron nut on something solid, or open the jaws of the vice wide enough for the head of a rivet to pass through, and

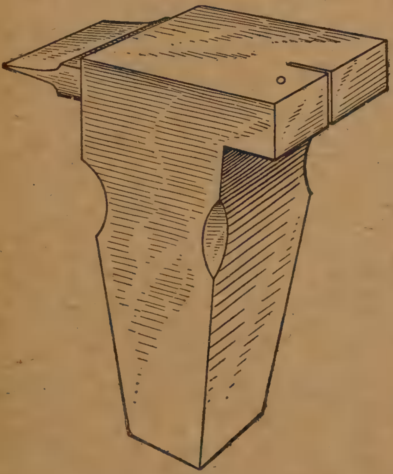


Fig. 1.—Cutler's Stithy

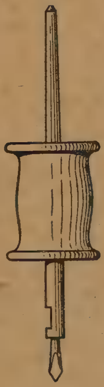


Fig. 5.—Drill Stock

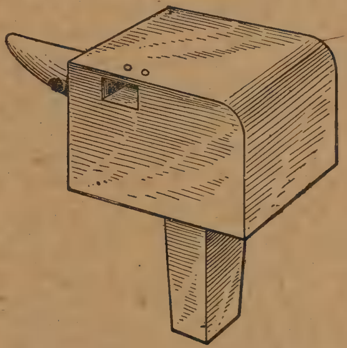


Fig. 2.—Scissors-smith's Stithy

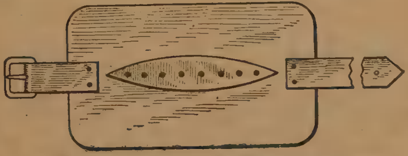


Fig. 3.—Cutler's Breastplate

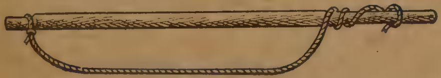


Fig. 4.—Drill Stick and Cord

punch out in that way. A cutler's stithy, with the right edge ground to a round shape, is very useful for setting scissor-blades. Emery grindstones are about 20 in. in diameter by 1 in. thick for knives and scissors, with a few smaller ones for razors, 4-in. stones being most suitable for the extra hollow-ground razors, with glazers a trifle less to fit the hollows. Glazers for pocket-knife blades, scissors, and the plainer ground razors may be about 10 in. by 1 in., with hard leather heads; but for table-knives, 12-in. or 14-in. glazers, with a softer leather head, are better. When ordering the tools, the worker should state the purpose for which they are intended—as, for instance, " One 12-in. glazer, suitable for table-knives," or " One 10-in. glazer, for pocket-knife blades," and the tool-makers will then know the head required. These grindstones are smaller than those used in cutlery manufacture.

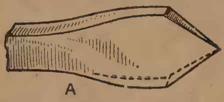


Fig. 6.—Drills

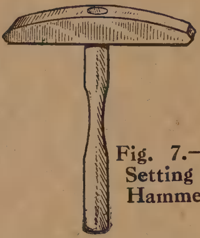
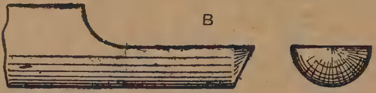


Fig. 7.—Setting Hammer



The breastplate Fig. 3) is worn by the worker when the drill stock shown by Fig. 5 is to be used. It is made from a piece of sheet-iron 6 in. long by 4 in. wide by about $\frac{3}{64}$ in. 18 s.w.g.) thick. It should be slightly concave, to fit the breast. The thick plate in the centre should be of steel, 4 in. long by $\frac{5}{8}$ in. wide by $\frac{1}{8}$ in. thick, and be riveted to the sheet-iron. The hollows for the end of the drill stock to rest in are made with the centre-punch. A hole is drilled through at each end of the steel plate, which is then bent to suit the iron plate, hardened and tempered, and the two are riveted together.

The drill is held in a stock to which motion is given by means of a bow. The cord of the bow (see Fig. 4) is fastened at the top of the bow stick, then passed through a hole near the lower end, returned through another hole about an inch lower, and tied. The drill

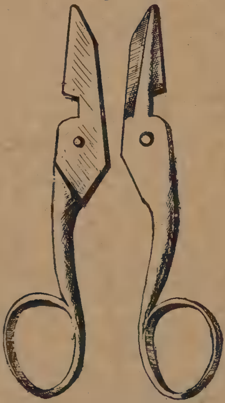


Fig. 9.—Buttonhole Scissors Shaped and Paired

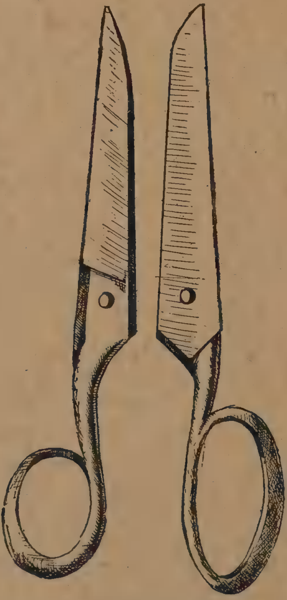


Fig. 8.—Pair of Scissors, Forged, Filed, Drilled, and Paired

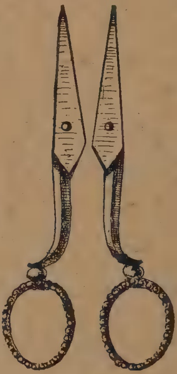


Fig. 10.—Fancy Scissors Shaped and Paired

points are made of two shapes: that used for drilling metal is flat and the end is shaped to cut both ways (as at A, Fig. 6), and bevelled at the edge similar to the steel chisels used for iron dressing; the drill for wood, horn, etc., is half-round in section and pointed at the end (see B, Fig. 6).

Setting Scissors-blades.—Fig. 8 shows the parts of a pair of cutting-out scissors, forged, filed, paired, and drilled, ready for grinding; Fig. 9 shows buttonhole scissors, and Fig. 10 ladies' fancy scissors at the same stage. Everyone knows that the cutting edges of scissors act on a different principle from knife edges; the edge of each blade is bevelled on one side only, leaving the other side flat; the two flat surfaces come together, and the material is sheared between the edges. Whilst a knife edge is straight, the edge of a scissors-blade is curved more or less sidewise from shoulder to point, and the efficiency of the scissors largely depends on the amount of this curve or set. If too much is given, the edges cut into each other, especially if one blade is softer than the other; while if there is too little they will not cut, and the material slips between the blades. In repairing, it is advisable to look down the edges of the blades before taking out the screw or rivet, to see if the blades have an equal amount of curvature or cut. If "off" the cut, they can be set "on" by a few strokes of the setting hammer on the thick or back edge of the blade at the part where the defect occurs. If the blade is too much "on" the cut, set off the inner side of the blade—on the back edge, of course. In each case, care must be taken to have the blade solid on the anvil, the blade being drawn towards the operator as it is being set, with the point inclined to the right when setting "on." Use the rounded edge of the anvil, which fits the hollow of the inside of the blade.

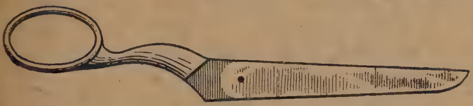


Fig. 11.—Scissors-blade with Ride

The Ride.—The two blades work together on a bearing, called the "ride," at the back of the hole, formed by filing away very slightly—often almost imperceptibly—the part immediately behind where the ride is intended to be, in most cases forming a half-circle from $\frac{1}{8}$ in. to $\frac{1}{2}$ in.—according to the size, etc., of the blade—from the hole (see Fig. 11). (The reader should unscrew a pair of well-made scissors and see for himself what is meant.) Buttonhole scissors invariably have the ride near the hole, to allow the corners of the blades to pass without cutting into each other, on account of the notch in the blades (see Fig. 12). In a pair of practically new scissors which only require setting of the edges, it is best not to interfere with the ride unless they will not cut in the "pinch" or shoulder. In such a case, carry the ride a little farther back, clearing it well away at the fore-side, as shown at Fig. 13; this will generally throw the edges "on" the cut at the pinch. When found to be rubbing right up in the joint, form a new ride. If "off" across the hole, set them "on" by tapping with the setting hammer on the outside of the rivet-hole. If inclined to be soft, a stroke or two with the flat hammer across the hole on the inside will have the desired effect.

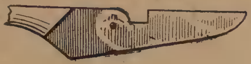


Fig. 12.—Buttonhole-scissors Blade with Ride

Grinding Scissors.—Many scissors are spoiled through being ground on the inside of the blade while the screw or rivet is in, this producing a hollow in the pinch; in such a case, grind evenly from the back of the hole to the point, till the inside of the blade is clear and the edge is brought up square. When setting the edges—that is, bevelling the edges—hold at a sufficient angle, and draw across the grindstone from pinch to point until the

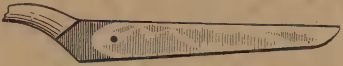


Fig. 13.—Ride Carried Back

burr formed shows that the edge is sharp. Always remove the burr on the whetstone (previously oiled) before putting the blades together, and put a drop of oil on the screw and on the ride before riveting up. Then try the scissors; if they will cut a piece of cloth or rag without holding unduly on the cut, they will do.

It will be found that garden shears and sheep shears are rather awkward to hold when grinding. When the rivet cannot be removed, a good plan is to knock off the wooden handles. The burr must be rubbed off the edges cleanly, as otherwise they will cut into each other.

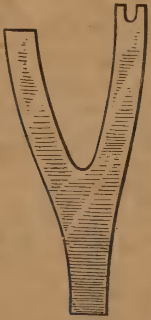


Fig. 14.—Brake for Pulling Scissors Shanks

Great care must be taken with hard scissors—that is, scissors which are hardened throughout the bows, shanks, blades, and screws. Fortunately for the repairer, they are not very numerous. They may generally be distinguished by the superior finish and style, and are usually of an ornamental pattern, but not always. The best way to test for hardness is to try the back of the shank with a sawfile. Ordinary plain scissors are only hardened to the hole. If a hardened screw breaks in the scissors, and it cannot be got out, hold in a gas jet to soften the screw, avoiding the softening of the blade as much as possible, and then proceed to drill it out. If the blade should get softened too much, heat to cherry-red and quench in oil.

A point to bear in mind in repairing scissors is whether the scissors are cast or made from forged steel. Many of the cheaper German and American scissors are made from cast steel, and being very brittle will easily break; others are so soft that it is impossible to get them to hold a cutting edge. Most of the American tailors' shears are lined blades—that is, the inside of the blade is of steel, and the outside and back of iron. These usually will allow of hammering on the cut, if off, the back being very soft. The lining mark is easily discernible on examination.

Great care must be taken with the large American shears, and with all tailors' shears, to have just the proper amount of cut on the blades; if there is too much, they will take pieces out of the edges.

Rivets.—To punch out a rivet or to rivet a pair of scissors together the blades should be open, not closed; if turning a screw out or in, the blades may be closed. An assortment of rivets of various sizes should be purchased and kept in stock; they are very cheap, and make a much better job than old nails when a new rivet is required.

Closing the Points.—When the points of scissors stand open and the bows fail to touch, they should be let through—that is, filed on the heel end in an inward slanting direction. See also that the points are clear. If there is plenty of clearance and yet the points stand open, pull the shanks in the vice or a " brake " (Fig. 14), with the edge of the blade towards the body; if the points are through too much, pull with the edge away from the body. The brake is made of $\frac{3}{8}$-in. steel, being about 6 in. on the longest side (see Fig. 14), and $\frac{1}{2}$ in. less (to enable the bow of the scissors-blade not being pulled to clear it) on the other. It is fixed in the bench with the thin edge towards the body and the longest side farthest away. The shanks of large scissors are pulled in the larger fork, and the small scissors, and those with short shanks, in the smaller fork. The shank is placed in the fork, and the thumb pressed against the front of the brake for leverage; it is then pulled sufficiently to bring the points of the scissors-blades into the proper position—that is, just covering. The brake can be placed in a hole cut in the bench, and taken out when not in use.

Bent-iron Work

Brackets, lamp standards, lanterns, candlesticks, vase and basin stands, and many other articles of general utility, can well be made in bent-iron. Some ornamental iron work requires heat to fashion, and strong tools and appliances and considerable knowledge to manipulate. But for bent-iron work, thinner and lighter material, which is more easily worked, is used with a similar effect. There is certainly a limit with the bent-iron material, but within this limit pretty and artistic effects can be produced.

It will be found necessary in making certain articles to use for the foundation iron of stronger character, the strip iron being used for the ornamentation only; but this applies only to the advanced work, as fully described later.

The material to be used is strip iron (see Fig. 1) of six different widths suitable for the various portions of the work required; the wider is used for the framework, the narrower for the scrolls and stays, and the narrowest for the clips to fix the work together, though in many cases the wider iron is used for this purpose. The thickness of the iron is No. 20 S.W.G. (·036 in.), and the strips are sold in 2-ft. lengths.

TOOLS

Shears.—Fig. 2 shows the bright hand shears which are necessary for cutting the strips to the required lengths, for trimming the cut edges, and, in certain cases, for cutting them round. It is well to have this tool of a fair size, as the length of handle gives leverage in cutting.

Pliers.—Fig. 3 shows the flat-nosed pliers, which are used for the general work, such as bending certain of the scrolls, clasping the clips, etc. Fig. 4 shows the round-nosed pliers, used for turning the scrolls and curves to the required shape. It will be found very useful to have two sizes of each of these pliers—say, 4 in. or $4\frac{1}{2}$ in., and 7 in.

The flat-nosed cutting pliers (Fig. 5) will be found very useful in closing the clips, and for cutting wire pins or rivets. Fig. 6 shows a pair of pliers especially made for closing the clips to the main framework, their shape enabling the worker to get at difficult positions more easily than with the ordinary pliers.

Punches.—The steel punch (Fig. 7) is used for making the holes in the strip iron when the strips, curves, or framework are fixed with rivets or screw bolts and nuts. Punches of three sizes, as shown, will be required. There are two methods of using these punches, the simplest method being that shown in Fig. 8. A piece of hardwood, cut flat across the end grain, is fixed in the vice, and the strip iron placed across it. The holes having been carefully marked, the punch is driven through by means of a hammer. Fig. 9 shows another method of doing this work. A bar of iron or steel, $1\frac{1}{2}$ in. wide by $\frac{1}{2}$ in. thick, has a narrow slit of the size to take the strip iron cut through the end, a hole large enough for the punch being bored through the centre of the bar. The iron strip, having been carefully marked for the holes, is passed through the slit, and a single blow of the hammer on the punch forms the hole, and the disc cut out falls through the bottom hole. This makes a clean hole, and there is usually no need for file or reamer to finish the hole, as is often the case when the wood block is used.

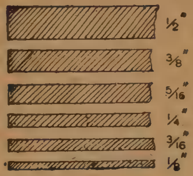


Fig. 1.—Sections of Strip Iron

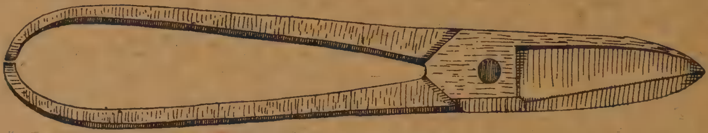


Fig. 2—Steel Shears for Cutting Strip Iron

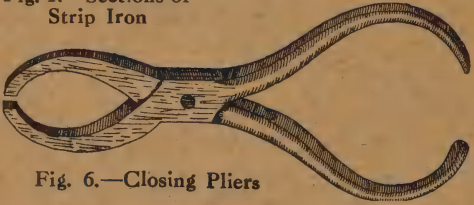


Fig. 6.—Closing Pliers

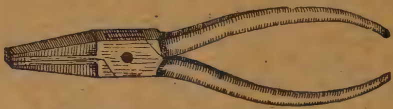


Fig. 3.—Flat-nosed Pliers

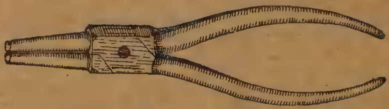


Fig. 4.—Round-nosed Pliers

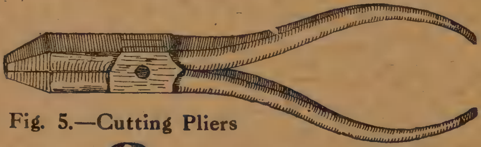


Fig. 5.—Cutting Pliers

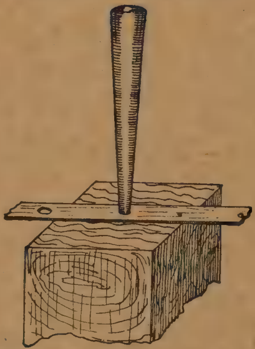


Fig. 8.—Steel Punch in Use on Wood Block

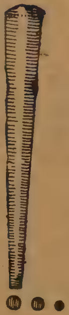


Fig. 7.—Steel Punch

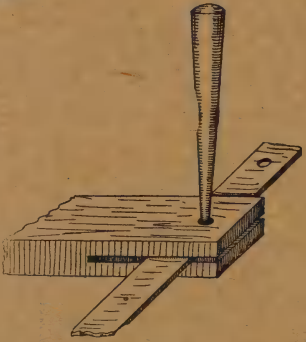


Fig. 9.—Steel Punch in Use on Iron Bar

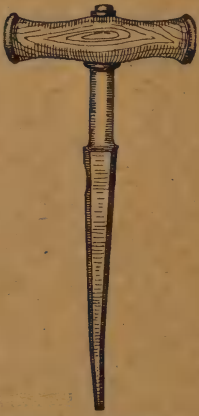


Fig. 10.—Steel Reamer

Reamer.—A taper-made reamer of hexagon steel is shown by Fig. 10. This will be found useful in enlarging holes where it is necessary to use a larger rivet or bolt and nuts, the holes in the strip iron being small.

Vice, etc.—A small bench-vice will be required. The ordinary kind will be useful, but one having parallel jaws will be best, especially when iron of a heavier kind is used for the framing. The work in progress may be held in the vice during most of the time, and especially so during any filing that may be required.

An ordinary hammer with one flat

face and one chisel-shaped end will be needed.

Anvils and Stakes.—A small bench anvil with flat-top face and rounded edge on one side and at edge on the other is shown by Fig. 11. This should have a square pin at the bottom to fit into a hole in the bench top. The scrolls after bending are flattened on this anvil with a wood mallet.

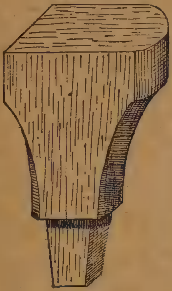


Fig. 11.—Bench Anvil

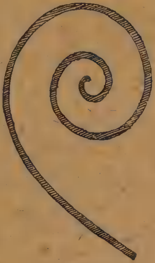


Fig. 17

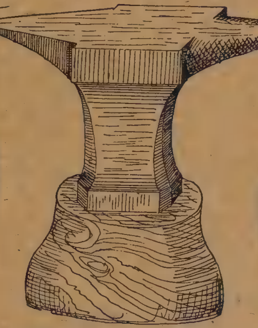


Fig. 12.—Stake with Double End

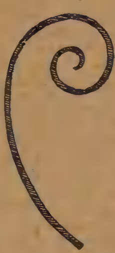


Fig. 18

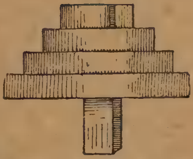


Fig. 13.—Cast-iron Taper Scroll Mould

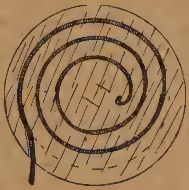


Fig. 14. — Mould with Iron Scroll in Position

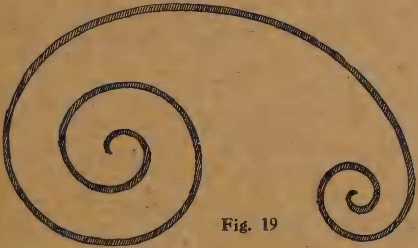


Fig. 19

Figs. 17 to 19.—Simple Scrolls

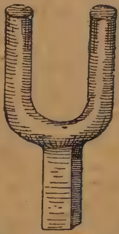


Fig. 16.—Simple Scroll Mould

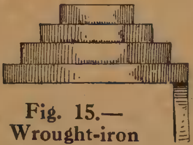


Fig. 15.—Wrought-iron Scroll Mould

The stake or anvil shown by Fig. 12 should be fitted into a wood block, and can be used on any part of the workbench as required. One side of this stake is flat tapered, the other side being round tapered, and it is thus serviceable for bending the scrolls and riveting together.

Scroll Blocks, etc.—A block used for turning the scrolls is shown by Fig. 13. This is made by cutting out a series of wood blocks tapering upwards, and fastening them one on top of the other. The top piece has a small slot cut out of the edge for the insertion of the end of the iron strip to be turned. The block thus made, with a square pin at the bottom for fixing in the vice or the stake, should be cast in iron, and will be a very useful tool. Fig. 14 shows the block with the strip of iron turned into a scroll. Fig. 15 shows a similar tool made in wrought-iron by turning a flat iron bar, say 1¼ in. by ½ in., into scroll form, leaving one end down to fix into the vice or stake. This mould must taper upwards as shown. The strip iron is turned round this mould. The iron scrolls, when lifted off these moulds, will require to be flattened on a flat iron plate with a wood mallet.

A small scroll mould made of round iron, with a square pin to fix in a vice, is shown by Fig. 16. The scrolls as made on these moulds or with the pliers may be set to good shape by the use of this tool. The scroll moulds described may be used for light iron work as well as bent-iron strip.

The tools described can be used on an ordinary work-bench or strong table, and they constitute a complete set to produce any variety of bent-iron work, as well as many examples of work with stronger iron framing. The beginner will not require all of them.

CURVES AND SCROLLS

Bending the C-scroll.—Before beginning to make any article in bent-iron, it will be well to practise the making of some of the simpler forms, so as to get into the way of working the material properly to make the curves and scrolls of true and regular form, and without kinks.

Figs. 17 and 18 show an ordinary scroll of two sizes, as used in the C-scroll and the S-scroll. It will be better, first of all, to draw the curves or scrolls full-size on a piece of strong paper, then, as the curve or scroll is in process of making, it can be put down on this paper template and corrected from time to time. When the template is drawn, the exact length of the strip to make the curve or scroll can be ascertained by passing a piece of string round the scroll, and cutting off the strip iron to this length with the small snips or shears.

To bend it, take the strip and hold it about 1 in. from the end in the jaws of the flat-nosed pliers, held in the left hand. Then take the round-nosed pliers in the right hand, twist the short free end of the strip into the small curve of the scroll, then with the pliers gradually work outwards, forming the enlarging curves of the volute according to the template on the paper. Then reverse the strip, and form the curve at the other end. This done, the C-curve as shown by Fig. 19 will be made.

The difficulty with beginners in this bending will be to form flowing scrolls without flat places or kinks. This can only be accomplished by practice. It is comparatively easy to make the small scrolls, the difficulty being with the larger and flatter scrolls. All flat places can be pinched out and good curves produced by the judicious use of the flat-nosed pliers. Still, it is better to learn the art of producing perfect curves at once.

Bending the S-scroll.—Fig. 20 shows the S-scroll, which is similar to the C-scroll in that the end volutes are larger, but differs in that the end volutes are opposite ways, the strip iron being turned during the operation. Figs. 21 and 22 show the C-scrolls with the volutes at the ends of the same size, but in the one case apart, and in the other brought close together. This scroll will be found useful in the various sizes, and easily works in with the framework of articles.

Other Scrolls.—Differing forms of scrolls based on the circle are shown by Figs. 23 and 24 ; but in one case with the ends scrolled. Fig. 25 shows the correct circle, which may be made with the ends to meet together, or the ends may cross each other about $\frac{1}{8}$ in. In each case the clip to fasten the circle to the frame should cover the joint.

Two forms of the S-scroll with square centres are shown by Figs. 26 and 27. These square parts are more easily dealt with by fixing them in the vice and hammering them square according to the template. The same result may be accomplished with the flat-nosed pliers.

Fig. 28 shows a form which will be found useful in filling up oblong spaces in ornamental panels, instead of a circle or an oval. Fig. 29 shows the method of working the scrolls together to form an ornament. The centre scroll is turned to give the oval shape at each end. The two C-scrolls fit at each side of the centre, and the whole is fastened together with the clip.

More ornamental forms, or the combination of the scrolls and curves to form ornamental patterns, are shown by Figs. 30 and 31. The design shown by Fig. 32 is an advance on the ordinary scroll end. The two ends of the strip iron are cut into leaf shape, and turned over as shown, making, with the wavy tendrils, a leaf panel.

Floral Forms.—The method of forming floral forms of the rose and lily in strip iron is shown by Figs. 33 and 34. These will be found more difficult to

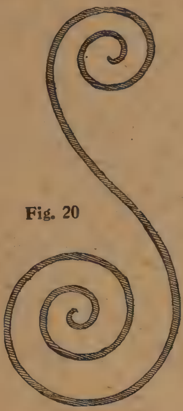


Fig. 20

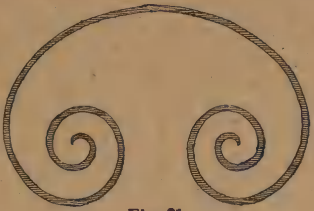


Fig. 21

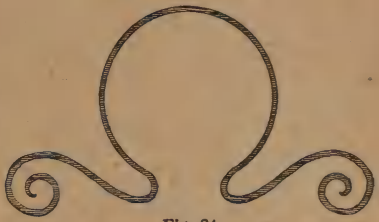


Fig. 24

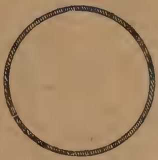


Fig. 25

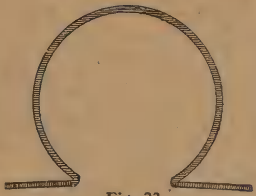


Fig. 23

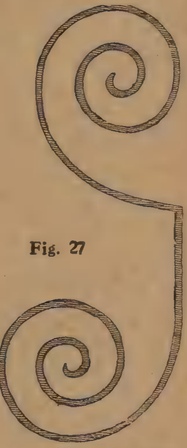


Fig. 27

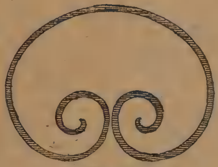


Fig. 22

Figs. 20 to 33.—Various Scrolls and other Ornamental Devices

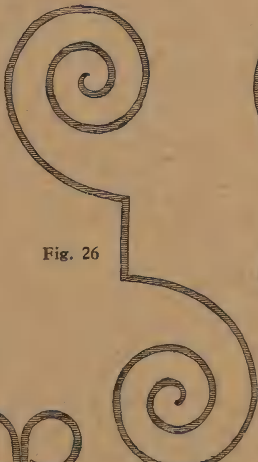


Fig. 26

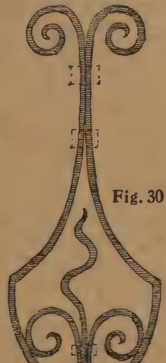


Fig. 30

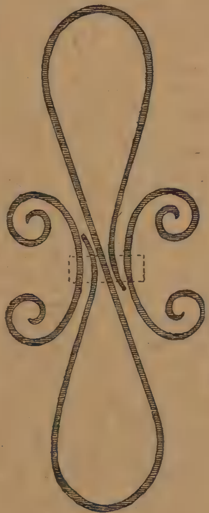


Fig. 29

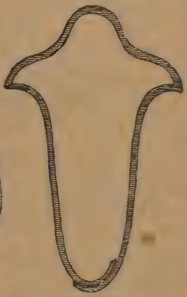


Fig. 28

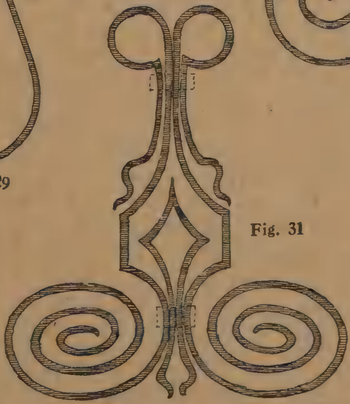


Fig. 31

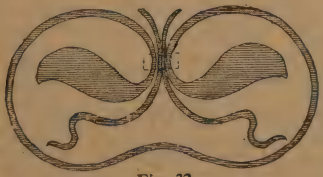


Fig. 32

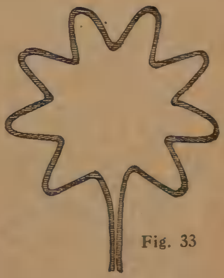


Fig. 33

produce; but when skill is gained it will be found comparatively easy, and they will much add to the ornamentation of screens, brackets, or panels.

Waved-line Forms.—Figs. 35 and 36 show the wavy lines with round or sharp angles. To produce these is more troublesome than difficult. The former kind is done with the round-nosed pliers. Hold the strip iron, and bend the first curve. Turn the pliers half round, and bend the second, proceeding in this way until the wavy line is completed. There may be some touching up, compressing, or stretching out required, but this is easily done. The sharp-angle wavy line is worked in the same way, but for this the flat pliers are used.

All the scrolls are much more easily made by using the scroll moulds, and they will be correct and true; but without these tools the pliers and vice must be used.

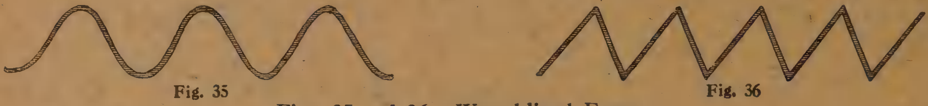


Fig. 35 Fig. 36

Figs. 35 and 36.—Waved-lined Forms

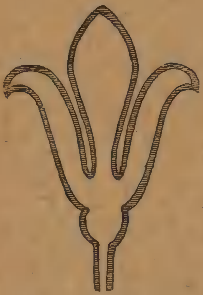


Fig. 34.—Flower Form

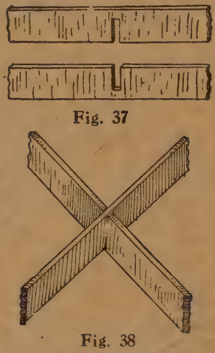


Fig. 37

Fig. 38

Figs. 37 and 38.—Making Cross Joint

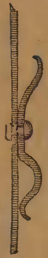


Fig. 48.—Parts Riveted Together

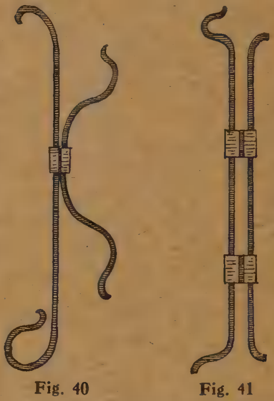


Fig. 40 Fig. 41

Figs. 40 and 41.—Fixing with Clips

Fig. 46.—Rivet

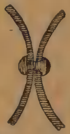


Fig. 49.—Parts Riveted Together

Fig. 47.—Bolt and Nut

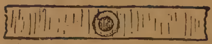


Fig 51

Figs. 50 and 51.—Fixing with Bolt and Nut

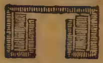


Fig. 45

Figs. 42 to 45.—Various Forms of Clips

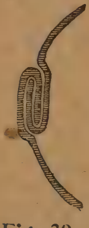


Fig. 39.—Joint in Ring

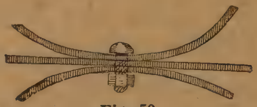


Fig. 50

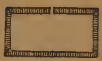


Fig. 42

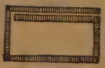


Fig. 43

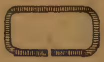


Fig. 44

JOINTS AND FASTENINGS

Cross Joint.—Having described the shape and method of making the scroll forms, the next thing is the method of fixing together. Figs. 37 and 38 show how to make a cross joint. Pieces are cut out of the strip iron with the shears, in the upper edge of one strip and the lower edge of the other. Then the two strips are fitted together and a cross joint is made. This will need care in making the slot square and true.

Clip Joints.—Fig. 39 shows the method of jointing a ring of strip iron with a clip joint. The edges are turned as shown, and then slipped one inside the other.

The ordinary method of fixing the strip-iron scrolls and shapes together with the clips is shown by Figs. 40 and 41. The clips may vary in width according to the position they are placed in, and the forms in which they can be made are shown enlarged by Figs. 42 to 44. They are fastened round the strips to be joined, and are fixed tightly with the special curved pliers as shown. It is important that they should be left quite tight and firm, as on this depends the rigidity of the article to which they are fixed. Fig. 45 shows the method of fixing the clip where the strips are required to be a little open, as in Fig. 41.

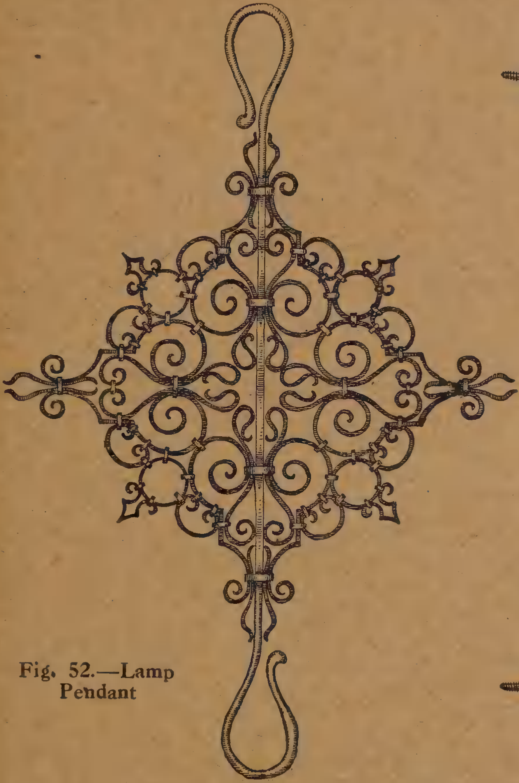


Fig. 52.—Lamp Pendant

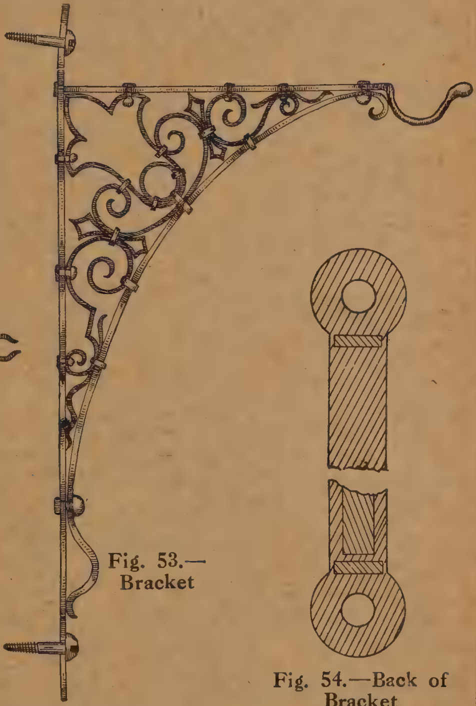


Fig. 53.—Bracket

Fig. 54.—Back of Bracket

Rivets and Bolts.—In many positions the clip cannot be fixed, in which case it will be well to use either the rivet (Fig. 46) or the bolt and nut (Fig. 47). Figs. 48 and 49 show the joints fastened with the round-headed rivet. The method of punching the holes in the strip iron has already been described. The holes must be carefully made, so that they come together. The rivet is put through the hole, and the chisel end of the hammer used on the end of the rivet, the strips being held on the bench anvil or stake iron. The riveting process may be made ornamental by using a cup punch over the rivet, this giving a rounded effect. Figs. 50 and 51 show the method of using the small bolt and nut; the nut needs to be very tightly screwed up.

SOME EXAMPLES OF BENT-IRON WORK

Hanging Pendant—A hanging pendant for a lamp or for a flower basket is shown by Fig. 52. To make this, flat iron $\frac{1}{2}$ in. wide by $\frac{3}{16}$ in. thick must be procured, and hammered into a hook form at each end; this may be 12 in. or 15 in. long. On each side of this bar a combination of scroll forms in strip iron is made and secured together with clip joints, and fastened to the bar hook with clips. The main scrolls should be of wide strip iron, and the smaller scrolls and ornaments of narrower widths. The scrolls used to produce this are those already illustrated. To work out this design will need considerable care and skill, as the clips must be made very secure and tight, and if placed well they add very much to the artistic effect. It will be seen that other combinations of scrolls may be used, and other effects thus produced.

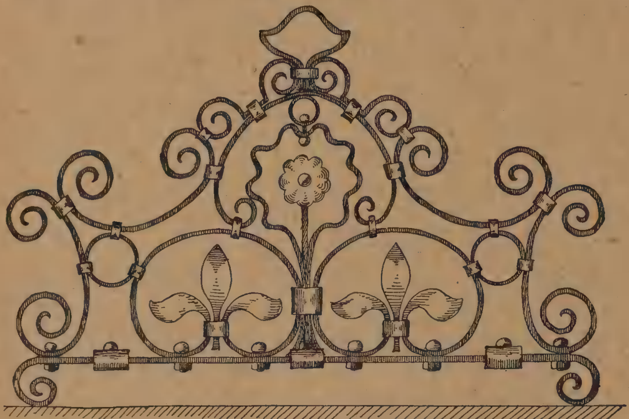


Fig. 55.—Newspaper Rack

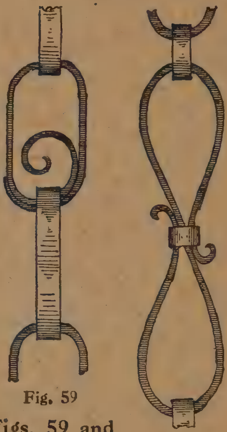


Fig. 59

Fig. 60

Figs. 59 and 60.—Bent-iron Chains

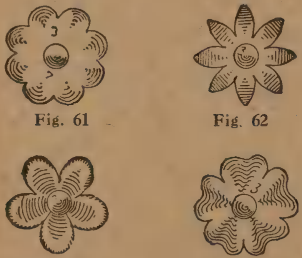


Fig. 61

Fig. 62

Fig. 63

Fig. 64

Figs. 61 to 64.—Rosettes in Brass and Copper

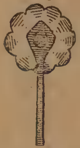


Fig. 56.—Fixing Brass Rosette

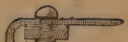


Fig. 58.—Cross-bars Bolted Together

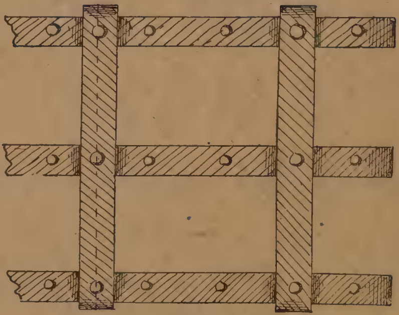


Fig. 57.—Plan of Stand for Newspaper Rack

Lamp Bracket—A simple bracket, suitable for a lamp pendant or a flower basket, and ornamented with strip-iron scrolls, is shown by Fig. 53. The back plate (see Fig. 54) has the upper and lower ends made circular. If the worker could not make the actual bracket, he could get a blacksmith to do so at very small cost, the iron used being only $\frac{1}{2}$ in. wide by $\frac{3}{16}$ in. thick; and the amateur could do the filling-in. The strip-iron scrolls and ornaments must be turned as before described, and fixed to the bracket frame with rivets and clips, as will be found illustrated in Fig. 53.

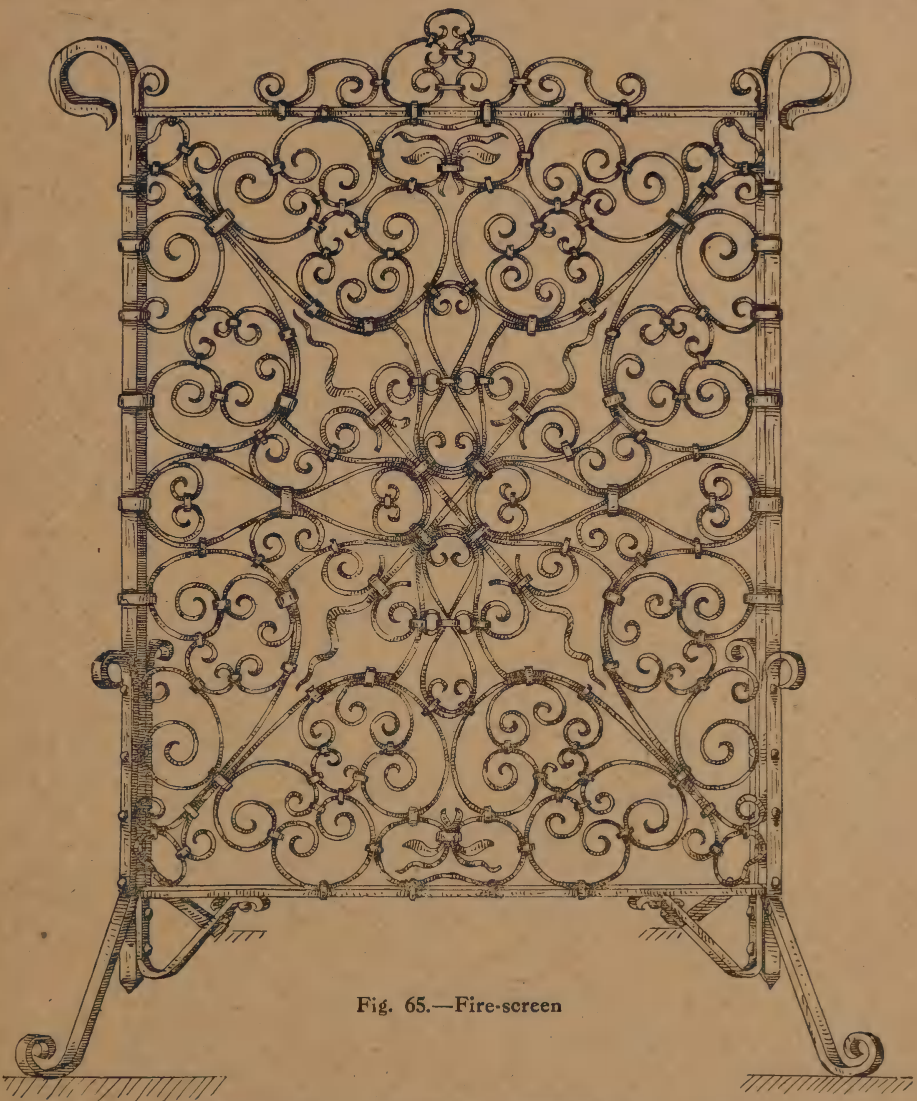


Fig. 65.—Fire-screen

Newspaper Rack.—A newspaper or magazine rack made by a combination of strip-iron scrolls, fixed together with clips, and secured to the bottom frame with bolts and nuts, is shown by Fig. 55. The central scrolls have the ends cut round into leaf-shape with the shears, and then twisted to show the flat side outwards, thus forming a leaf. The central ornament is a piece of strip iron waved, and then turned into circular form, making a rose. In the centre of this flower, a small brass rose may be screwed as shown in Fig. 56, thus adding to the effect. The stand (Fig. 57) should be made of three flat iron bars $\frac{5}{8}$ in. wide by $\frac{3}{16}$ in. thick, scrolled at the ends as shown in Fig. 55. To these bars the central scrolls are fixed with round-head bolts and nuts. The cross bars are of wide strip iron turned down at the ends and secured to the three flat iron scroll bars with bolts and nuts as shown in Fig. 58.

Chains.—Figs. 59 and 60 show methods of making chains of ornamental pattern in strip iron. These require care and precision in making to obtain good effect. Each link is made of one piece of strip iron, bent so as to give strength as well as good effect.

Ornamental Floral Forms.—Forms of flower ornamentation which may be used in various positions by fixing with a rivet or bolt and nut to the scrollwork are shown by Figs. 61 to 64. The ornaments may be of brass, copper, or german silver, cut out of sheet about No. 19 or No. 20 B.W.G., and hollowed up slightly. This hollowing may be easily done with a piece of thick cast lead having a hole hollowed in it, and then hammering the sheet brass into the hole with a round-faced hammer. Or the hollows may be repousséd on a pitch block or sand block.

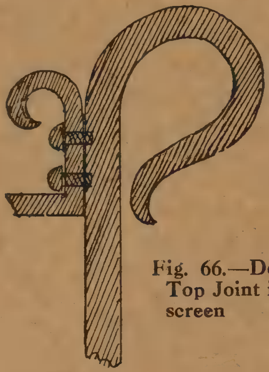


Fig. 66.—Detail of Top Joint in Fire-screen

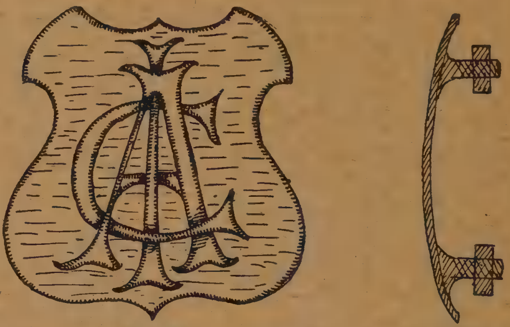


Fig. 69 Fig. 70

Figs. 69 and 70.—Repoussé Shield and Method of Fixing It

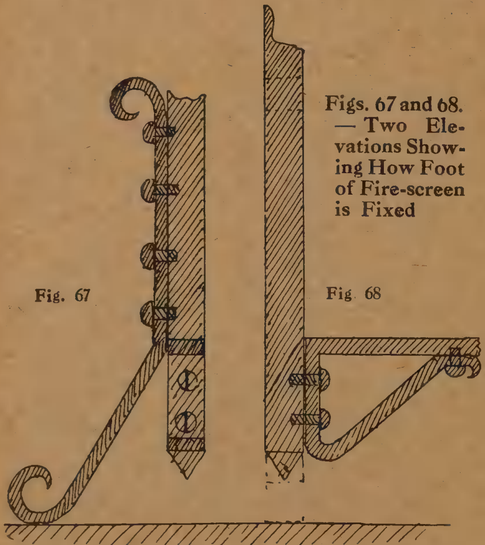


Fig. 67 Fig. 68

Figs. 67 and 68. — Two Elevations Showing How Foot of Fire-screen is Fixed

Fire-screens.—A fire-screen is an excellent addition to the ornamentation of the open fireplace during the months when no fire is required. Bent-iron work lends itself readily to the ornamentation of an ordinary iron frame, and Fig. 65 shows how the various curves already illustrated can be adapted to fill large spaces, and by their combination produce a variety of forms and a really artistic effect. An article of this kind, of course, requires that the framework must be strong and rigid to stand firmly, whilst the thin bent-iron is used for the ornamentation. This screen has been designed in such a way that some of the tools described early in this chapter can be utilised in making the framework, simply by heating the iron bars red hot, and turning them in the tools as already described.

Fig. 65 shows the fire-screen complete. It may be of any ordinary size to suit the fireplace, but 18 in. or 20 in. wide and from 24 in. to 27 in. high will be found very suitable. The two side pillars may be of iron ½ in. square, turned to a simple scroll at the top and just pointed at the bottom, as shown enlarged in Figs. 66 and 67. The feet may be of flat iron ½ in. wide by ¼ in. thick, turned at the top and bottom ends as in Fig. 67, and screwed to the side pillars with round-head screws. The top and bottom rails are turned with scroll ends (see Figs. 66 and 68), and secured to the side pillars with round-head screws.

After the framework has been made (by a blacksmith, if it is beyond the amateur's capabilities), the pattern should be drawn full size on a sheet of paper, and the strip iron carefully and correctly bent to the various shapes. Then, the framework being laid flat on the full-size drawing, the scrolls can be fitted in their places, carefully joined with the clip joints, and secured to the framework with the clip joints where necessary, and with rivet and bolt and nut where the rigidity will be improved by this method. The crossing iron in the centre should be cross-jointed, and a small bolt and nut used under the four clip joints round the centre. This will give firmness to the centre of the work. When put together it may be painted dead black, or any enamel colour. The fire-screen may be improved in appearance by using polished strip brass or copper for certain of the smaller scrolls, thus brightening the general effect at very small extra cost. Or a repoussé shield, as shown by Fig. 69, having the monogram or a date on it, in polished brass or copper, would have an excellent effect; it may be fixed by soldering two screws and nuts at the back, as shown in Fig. 70.

Flower Bowl.—Fig. 71 shows a glass or china bowl of small size, say about 5 in. in diameter. The stand design embraces the simplest forms of scrolls, which are fitted up entirely with clips. First the shape of the bowl should be drawn in outline on a strong piece of paper, white or brown. This bowl may have four supports as shown, or three supports if desired. The shape of the scrolls forming the supports should be drawn out on the paper round the shape of the bowl. A single line will be sufficient, but care must be taken that the shapes of the scrolls are true. Then take a piece of string or, better still, a piece of thin wire, and pass it round the scroll shape on the paper. This will give the exact length of the iron required to make the scroll. Then with the shears cut off the various lengths of strip iron required. With the round-nosed pliers begin at the smaller scroll, and bend the strip to the shape, using the flat-nosed pliers as necessary to keep the iron flat, placing it on the sketch on the paper (which is the template) to see that the scrolls are kept to the shape required. The wide strip iron should be used for the

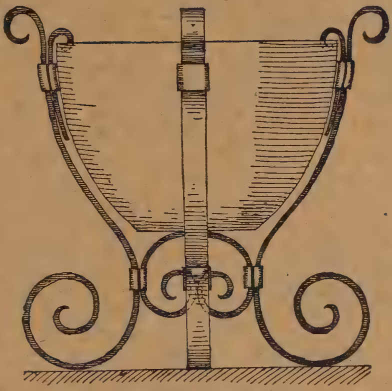


Fig. 71.—Flower Bowl

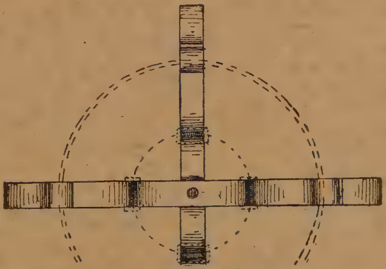


Fig. 72.—Plan of Bowl

Fig. 73.—Enlarged Plan of Clip Joint

outside scrolls. Fig. 72 is a part plan showing by dotted lines the bowl shape and how the supports fit together.

If four supports are used, the smaller C-scrolls that connect them may consist of two C-scrolls crossing each other, as shown in Fig. 72. If three supports are used, three single scrolls may be fastened together in the centre with a small rivet or bolt. The three small simple scrolls at the top are used to keep the glass bowl in position.

When the supports and the C-scrolls are bent, the two supports and one C-scroll should be fastened together with the strip-iron clip as shown in Fig. 73, the strip iron used for this purpose being ¼ in. wide. This must be cut off to length, turned tightly round the two thicknesses of iron, and the ends made to meet in the centre as shown; then fix tightly with the larger pliers. The other pair of supports must be made in the same way, and then put together and fastened with a rivet or bolt and nut in the centre of the C-scrolls, as shown in Fig. 72. The glass bowl should then be placed in position, and the upper scrolls fastened with clips as already described.

The bowl should then be removed, and the stand painted dead black or, if preferred, enamelled. When this is done the bowl could easily be placed in position by slightly moving outwards one of the supports. This stand is one of the simplest that can be made, with the exception of the rivet or bolt in the centre of the C-scrolls, with the clip joints. Different effects can be made by the use of scrolls of other shapes.

Dead black for Bent-iron.—A dead-black paint may be bought, or it may be made as follows: Mix well together 7 lb. of pure drop black ground in turpentine with ½ pt. of japan gold-size, thinned down to proper consistency with american turpentine. This dries hard with a dead-black finish.

Making Incandescent Gas-mantles

WHILE there may be two opinions as to the propriety of including information on making incandescent mantles in a work addressed to the amateur mechanic, there can be no gainsaying the great interest that has been and is still being evinced in the subject by thousands of people who regard the home manufacture of gas-mantles as a possible source of livelihood, and the Editor of the present work has received many hundreds of requests from amateur mechanics for information on the subject. It is very doubtful whether this much-advertised form of "home employment" can pay the worker—especially in cases where he is compelled to buy his appliances and all his materials from the firm that is expected ultimately to purchase his mantles—but from this chapter the reader will be able to gain a very fair idea of what the process necessitates in the way of appliances, materials, and skill.

Preliminary Treatment of the "Stocking."—In the home manufacture of incandescent gas-mantles extreme care is necessary. A supply of the raw knitted cotton or of ramie fibre, in the form of a long tube or "stocking," is necessary. The ramie fibre, or so-called China grass—really obtained from an Indian thistle—is the strongest. A preliminary treatment is required first with dilute acids and then with dilute alkali solution, to remove all traces of iron, grease, and other impurities, which would greatly detract from the brilliancy of the light. For this operation vessels of glass or earthenware must be used; on no account should metal be employed. First immerse for one hour in pure hydrochloric acid 1 oz. and water 20 oz. Wash well, and next immerse for one hour in liquor ammoniæ (·880) 1 oz. and water 20 oz., again well washing. Finally wash in distilled water. The washed fabric is allowed to dry on cords or on nickel wires in a place free from dust.

Dipping.—The "stocking," when dry, is cut up in pieces about 9 in. long (though many prefer to do the cutting-up before washing), and a hem is made at one end about 1 in. wide, strengthening this, if preferred, with a strip of tulle or other thin, soft fabric. The lengths of "stocking" are now ready for dipping.

It has been found that the best solution for this purpose consists of 99 per cent. of thorium nitrate and 1 per cent. cerium nitrate. Curiously enough, if nothing but thorium nitrate is used, or if the proportion of cerium nitrate is materially increased, the light is much inferior. A suitable formula is: thorium nitrate 1 lb. 14 oz., cerium nitrate 5 dr., and distilled water 100 oz. The salts should be dissolved in a perfectly clean glass vessel, and the solution agitated to ensure mixture.

The lengths of washed cotton or ramie fibre are immersed in the solution until well soaked, for which a few minutes usually suffices. The excess solution has then to be gently pressed or squeezed out, so that the salts may not clog up the meshes in the fabric. On a small scale this may be done by simple pressure with the perfectly clean fingers; but in manufactories machines having a pair of rubber rollers are employed. The whole of the solution, of course, is not to be extracted; in fact, on the amount left behind really depends the greater or lesser brilliancy of the mantles. The squeezed-out liquid is kept, and may be used over again.

One pound of thorium nitrate is enough for about 300 good quality mantles, or about 400 of the cheaper kind.

A less expensive mixture is: zirconia 30 per cent. and alumina 60 per cent. This forms the framework, and is afterwards coated over with chromium oxide.

Drying the Dipped Fabric.—The next proceeding is to place the dipped lengths of fabric on cones or mandrels of glass to dry. It is better to let them drain a little first, as this tends to prevent too much of the solution being left on the mandrels, and obviates any chance of sticking. The drying-room should be kept warm, well ventilated, and free from dust. Drying normally takes about twenty-four hours.

Suspension Cord.—The asbestos suspension cord is then to be fixed in place. This is usually from 1½ mm. to 2 mm. in diameter and is threaded in a needle. The turned-down hem is creased or gathered two or three times at opposite sides of the opening, the needle is inserted across the middle of the aperture, passed to the left through the gatherings on that side, then brought round to the front and through the creases on the right, finally passing it again across the middle of the opening, close to the first thread. If all has been correctly done there will now be a double thread across the opening, and on pulling this the gatherings on each side will be drawn together. Examination of a shop-bought mantle will help to explain the procedure, though these are not all done in exactly the same way. The cords should not be drawn too tight, or the shrinkage that takes place during the after operations will tend to break the top of the mantle. The two central threads are bent up to form a loop, and the ends are fastened off.

Stiffening Mantle Necks.—At this stage the neck of the mantle may be stiffened by applying a mixture of ferrous sulphate, with liquid gum arabic to bind it and a little aniline red for colouring. This may also be used to stamp the name on the mantle at the same time, as it will show up dull on the incandescent ground. Some workers, however, simply give the neck another coating of the thorium and cerium dipping solution; while in many of the very cheap mantles the neck receives no extra treatment at all, which doubtless explains why they drop to pieces so easily.

The mantles are now placed over hard beechwood mandrels of the correct form, to bring them to a good shape, and are then ready for burning off and hardening.

Burning Off.—For these operations the mantle under treatment is suspended from a nickel wire support, having a hook to engage in the asbestos loop and fixed to a wooden base with adjustment for raising or lowering. There will be required a hand bunsen burner with flexible tube connection and also a high-pressure stand bunsen, not unlike those used for chemical experiments, only of special make and usually needing some form of compressing plant.

On a small scale, practically any high-pressure atmospheric burner giving a flame about the size of the mantle will answer. It is a good plan to suspend the mantle ready over the stand burner, but without lighting the latter.

All being prepared the hand burner is lit, and the top of the mantle is ignited, the flame being kept playing on the top until the mantle is burnt off right to the bottom. It will now be much shrunk and of a bad shape and colour. The high-pressure stand burner is now turned on a little only, and lit across the folds of the mantle. The burner is then gradually turned full on, while still playing the hand burner over the top of the mantle. The action of the high-pressure burner is to make the mantle fill out, improving its shape ; also the heat serves to strengthen or temper it, and to whiten it. The ordinary low-pressure domestic supply is not suitable for this purpose, it being necessary that the mantle should undergo exposure to a much greater heat than it will ever be called upon to experience in use, so that there may be no further shrinkage.

Hardening or Stiffening. — The mantle is left on the burner a short time to season. The burning-off reduces the size to about one-half, and only the ash and rare earths are left. In its present condition it is too delicate for transportation, and will have to be stiffened by immersion in collodion, to which a little castor oil has been added to prevent brittleness. A good formula for this is : gun-cotton 12 dr., sulphuric ether 2 lb., and castor oil about 1 oz. The gun-cotton is highly explosive, while the mixed collodion is very inflammable, having accordingly to be used in a room without fire or lights, and, as the fumes are heavier than air, downward ventilation is necessary. Inhalation of the fumes to any extent should be avoided. The mantles should be immersed with great gentleness to avoid breaking them. It is at this point that many workers come to grief, especially if they have omitted to stiffen the necks. The collodion having set, the now finished mantles are cut off to the right length and packed in boxes. Inverted mantles are made in a similar way, except that the fabric is attached at the edges to a clay ring by means of an asbestos cord.

A valuable illustrated pamphlet on home manufacture, to which the writer acknowledges indebtedness, is that of J. Perroux, " Manière de fabriquer soi-même les capuchons à incandescence par gaz " (1897).

Incorrodible Paints or Inks

A PAINT or ink is sometimes wanted for use on labels, etc., where it will be subject to the action of moisture, acids, etc. The best pigments for the purpose are plumbago for black and vermilion for red (not vermilionette, which is very fugitive). Obtain these pigments in a state of fine powder and rub them up with a medium consisting of copal varnish or amber varnish or a mixture of 1 part of genuine Trinidad asphaltum and 4 parts of turpentine. The plumbago is not affected by prolonged subjection to sunlight, but the vermilion is not so permanent.

Boot Repairing: Many Varied Operations

EARLIER chapters have described in detail how to make riveted and hand-sewn boots and how to attach new soles to old boots by means of either rivets or stitches. There remain to be described a number of operations—chiefly varieties of patching—and these will now be dealt with, while some special matters relating to rubber-soled and other sports goods will form the subject of the later pages of this chapter, which will conclude the course of lessons in boot and shoe making and repairing.

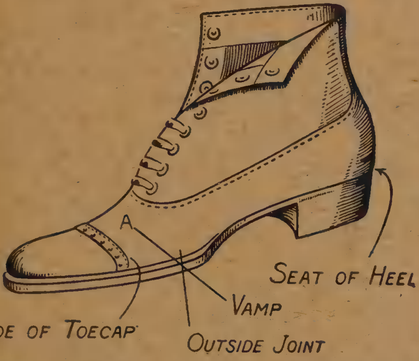


Fig. 1.—Positions of Breaks in Boot Upper

INVISIBLE PATCHING

The chief places in which boot uppers break in wear are at the outside joint (caused by over treading), by the side of the toe-cap, on the vamp at point marked A in Fig. 1, and round the seat of the heel. In children's boots the toe-caps are also usually rubbed through during wear. All of these repairs can be executed by the "invisible patching" method—that is, by means of solution.

A quantity of mixed patching leather will be required, which should include some pieces big enough for toe-caps. The leather should consist of calf, box-calf, black glacé kid, and brown glacé kid. The box-calf and glacé kid, being chrome tanned, do not contain grease, and therefore lend themselves readily to the solution; but the calf leather takes a little more trouble. The calf is distinguished

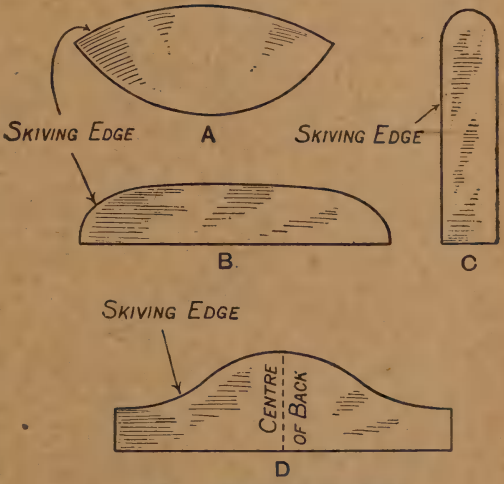


Fig. 2.—Shapes of Patches

from the other leathers by its dull appearance and its greasy touch, whilst the chrome leathers are bright and dry.

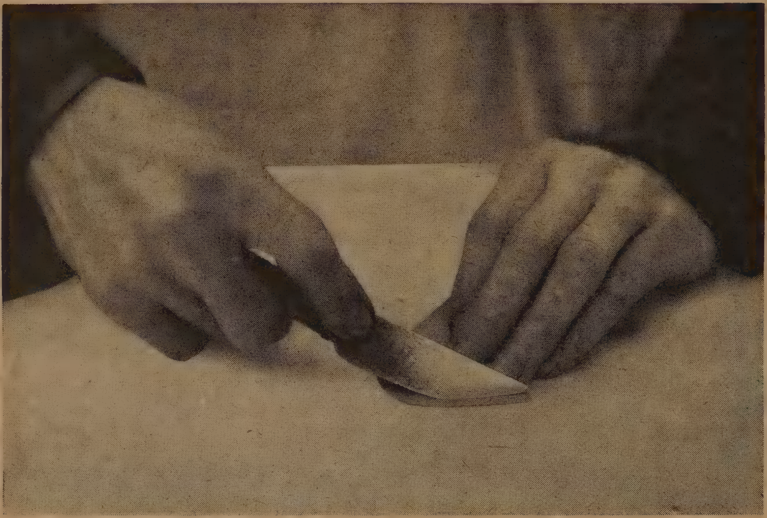


Fig. 3.—Skiving a Patch

It should be remembered that much of the success in invisible patching depends on matching the patch nicely with the shade and appearance of the boot upper.

A bottle of solution costing threepence will be required, and may be obtained from the leather stores. For applying the solution, cut a piece of stick about 3 in. long and slender enough to be dipped into the bottle easily. Thin down one end, and slightly hollow it out. When the stick is dipped into the bottle, the hollow part will carry a small quantity of the solution.

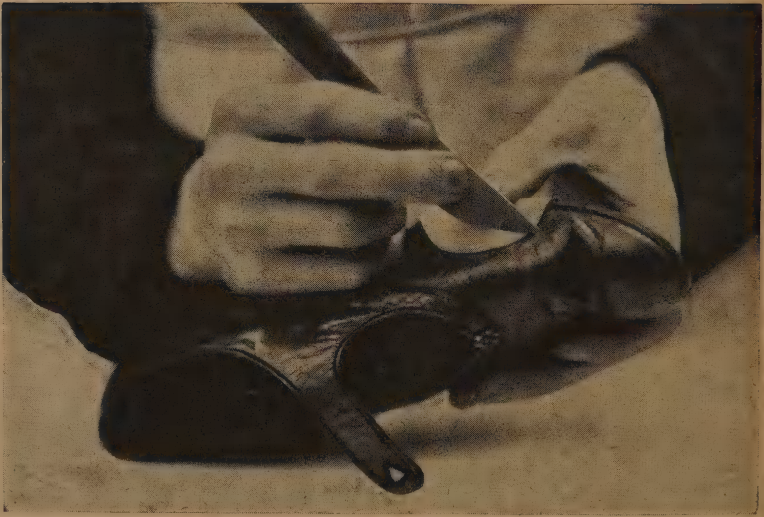


Fig. 4.—Marking Upper for Solution Patch

Cut the various patches to the shapes shown by Fig. 2. A shows a patch for the toe-cap, B a joint patch, C a cap patch, and D a patch for the seat of the heel. The edges of the patches will need to be skived down to an exceedingly fine edge (see Fig. 3), so as not to show the joining on the boot upper, and also to prevent the patch from curling away from the upper in wear. Obtain a piece of thick glass on which to lay the patches when skiving. Lay the patch, undressed-side upwards, on the glass, and hold firmly down with the left hand. The knife must be very sharp at the end. Hold the knife almost flat on the material, about $\frac{1}{4}$ in. inwards from the edge, and skive towards the edge. The best skive will be made if it is done at one stroke. Raise the knife a little as the edge of the patch is neared, and cut clean through the extreme edge. The finer the edge substance the better. If the edge seems a little jagged do not trouble; but on no account attempt to trim up the "raw" edge when the patch is skived.

Now with the buff-knife (scraper) scrape the patch behind where the skiving was begun. Scrape as much of the patch as will be attached to the upper; but not the portion which will afterwards have to be sewn down or "lasted in." Next place the patch in its intended position against the boot upper, hold tightly, and with a sharp pointed knife mark round the edge of the patch, just piercing the face of the upper (see Fig. 4). This must be done very exact.

If the upper is of glacé kid it will be possible to strip off the face of the leather within the knife mark, and this will leave a blue surface underneath. If the upper is of box-calf or calf, lightly skive the upper within the mark.

See that the boot upper and the patch are quite free from dirt, and apply the solution with the stick. Let the residue of the solution be to the extreme edge of the patch, and just along the mark on the upper. Leave now to dry, and when the solution appears quite white, the patch may be attached. If calf is being used, however, it is advisable at this stage to give the boot upper and the patch a second coat of solution.

To attach the patch proceed as follows: Take the boot in the right hand and the patch in the left hand. Pass them alternately very quickly over a gas flame, and when the white colour changes to a dirty grey, stick the patch quickly in position. Make quite certain that the patch is in the correct position, for if the edge of the patch happens to overlap the mark on the boot upper, just so much as overlaps will curl and be very unsightly in wear; whilst if the patch is placed below the line there will be a danger of the upper breaking at the uncovered part, owing to its being weakened by the skiving. As soon as the patch is stuck, smooth down the edge with the thumb. This will bed the fine edge down, and force out the surplus solution.

It is an advantage to have a wooden last in the boot; in this case tap all over the patch gently with the hammer, and place the job on one side to thoroughly set before attempting to sew down or "last in" the patch.

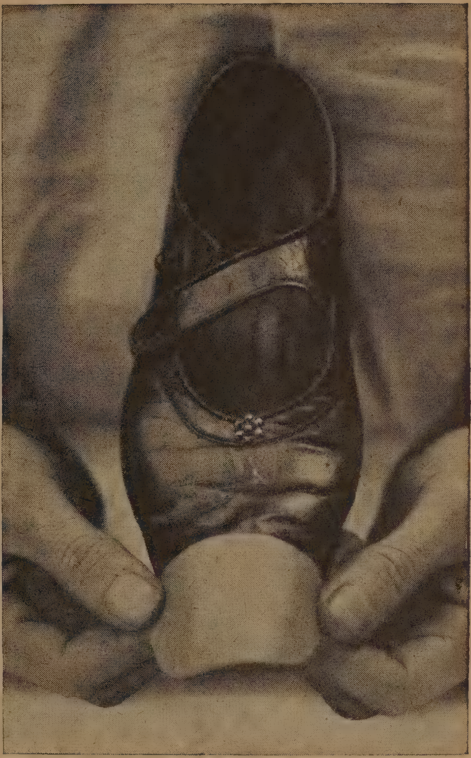


Fig. 5.—Sticking on a Toe-cap

In attaching a toe-cap on a boot which already has a cap, do not remove the old toe-cap. After cutting out and skiving the new cap, place it in position on top of the old one, with its edge close up to the second row of cap stitches—that is, the row of stitches nearest the toe end of the boot. Mark there and skive, and the border of the old toe-cap will act when the job is finished as the border of the new cap. When sticking on the cap, hold the boot between the knees, the toe pointing away. Hold the cap by the extreme corners, and as soon as placed in position pull tightly at the cap corners (see Fig. 5). If this is not done the cap will have a tendency to "sag" or wrinkle during wear.

In putting on a patch near the edge of the toe-cap, allow the patch to come just over the toe-cap border, and when skiving the upper, after marking, cut away the square edge of the cap within the marking.

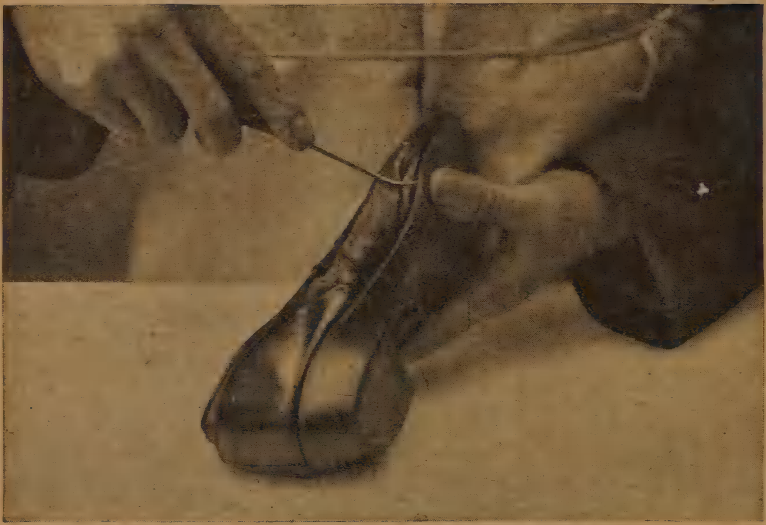


Fig. 6.—Sewing-down

When cutting out a patch for a broken seat, choose material of a stout substance, as the strain round the heel is very great once the seat has broken away.

Finally, when heating the solution on the patch and boot, move both very rapidly backwards and forwards, and do not place them too near the light. This solution is highly inflammable, and, when finished with, the bottle should be corked very tightly, as otherwise it will deteriorate very rapidly. Solution of which the liquid turns white in its bottle is useless.

SEWING-DOWN

Sewing-down a Toe-cap.—When a toe-cap is to be stitched on, the method is as follows: First remove all protectors and hob nails, if any, round the toe of the boot sole. Turn back the cap, and open the welt by running the rasp round between the welt and the upper, pressing heavily on the welt edge with the file side of the rasp. Turn the cap back again to its first position, and trim off the surplus leather level with the bottom edge of the boot sole. This will help in taking out the pleats whilst sewing down. Insert a wooden last into the boot, the toe of the last being near the shape of the boot toe. With the handle of an old knife, the end of which has been previously cut to wedge shape, force the cap between welt and upper all the way round.

Begin sewing a couple of stitches behind the toe-cap corner, holding the boot between the knees, with the toe pointing towards the worker. Let the first stitch, covering the cap corner, be a little longer than usual, as a small stitch will cut through the cap edge. When pulling up the stitch on the cap side, hold the cap corner down tightly. Now proceed with the sewing, and as each stitch is pulled up in the welt side, pull the cap tightly forwards. This will prevent pleats (or "pipes") from forming round the cap. Make the last stitch covering the cap corner a little longer, as with the first stitch, and finish sewing a couple of stitches beyond. Rub round the welt with the knife handle previously mentioned, and trim off the cap leather flush with the edge of the sole. Rasp and scrape the edge and "finish off."

Sewing-down Patches.—The above description applies also to the sewing-down of patches (Fig. 6 is a photograph showing the sewing-down of a side patch), excepting the heel patch. The stitches for this patch will have to be brought out on the heel in the position shown in Fig. 8. A groove will also have to be cut in the heel to receive the stitches. To cut this groove, hold the knife, pointing downwards towards the top-piece, at an angle. Place the point between the seat and the first lift, and proceed cutting so far as required for the extent of the patch. Turn the boot round, bringing the top-piece uppermost. Place the knife point between the first lift and the second, pointing towards the first lift, and proceed cutting as far as before. The freed leather can now be removed, and the groove is ready for receiving the stitches.

Trim off the surplus patch and place the boot between the knees, heel to the worker's body. Begin sewing, working towards the worker. An awl with a good curve will be required for this operation, so as to work well into the seat, and then bring the awl point out in the groove made in the heel. Open up the seat between the upper and sole leather before beginning the sewing. When the sewing is completed, trim the patch flush with the heel, and hammer the groove to close it as much as possible. Finish the heel in the usual way, filling up the groove with heelball.

For a man's heel use an eleven-cord thread, and stitch four to the inch. For a woman's heel use a nine-cord thread, and stitch six to the inch. For a man's toe-cap use nine-cord thread, and stitch six to the inch; and for a woman's light boot use seven-cord thread in sewing down the cap, and stitch eight to the inch. For heavier men's caps, stout edge sole, use an eleven-cord thread, as also for boy's rough strong boots.

LASTING-IN

Lasting-in a Side Patch.—If a boot is machine sewn, not previously re-soled, cut the stitches between the sole and the middle, or the sole and the lasting—according to whether single-sole boot—insert the lifting awl between the upper and the middle sole, and lift up. Now force the loose end of the patch underneath (see Fig. 7), seeing that the patch corners bed well to the upper and do not "sag." Rivet the sole down with rivets long enough to touch the insole.

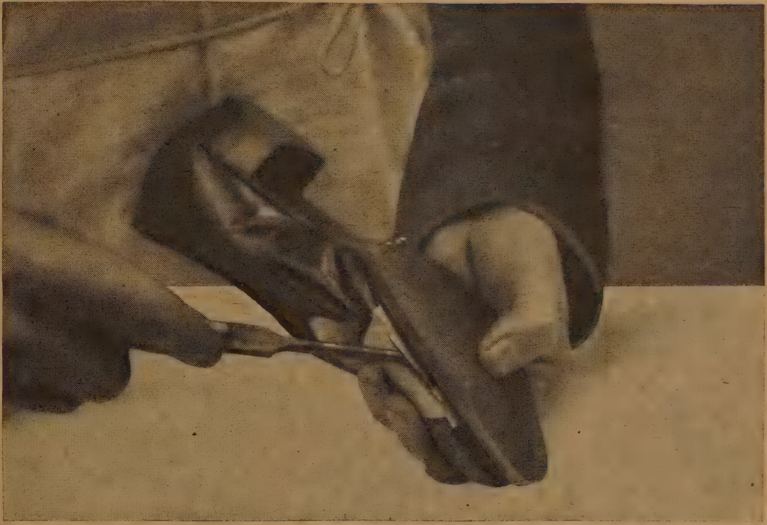


Fig. 7.—Lasting a Patch Under

If the boot has had a sole riveted on, the only difference in the operation is that, instead of cutting the stitches, the sole must be lifted to release the rivets from their hole on the insole, and the released rivets withdrawn. If the boot is a welted one, however, the patch will have to be sewn down.

Lasting-in a Toe-cap.—This can only be done in the case of the boot requiring to be re-soled as well. Strip off the sole, lift up the middle sole, and turn it back beyond the extent of the cap, fastening it down to the sole in this position with a long rivet. Pull the boot well back, so that the toe of the last fills the boot toe. With the claws of the lasting pincers (Fig. 9) take hold of the edge of the cap in the centre of the front and pull firmly forwards. Place a tingle at this point and drive in flush. Pull up the left-hand corner in the same way, and fasten down with a tingle. Next pull up the right-hand corner. and again fasten down with a tingle. Now take hold of the cap just to the right of the centre tingle, pull up, and drive in a tingle. Then with the knife point cut the cap just to the right of the tingle last driven; but do not let the cut extend quite to the lasting edge or the edge of the insole. Take hold of the cap just to the right of this cut pull up, twist the pincers to the left, and fasten down with a tingle. This is to take out the pleats and allow the lasting to lie flat. Continue in this way to the right-hand corner tingle.

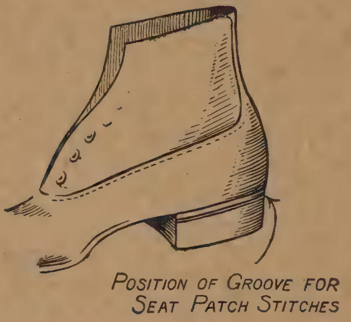


Fig. 8.—Position of Stitches in Heel for Seat Patch

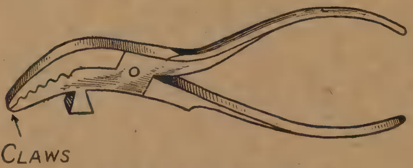


Fig. 9.—Lasting Pincers

Next take hold of the cap to the left of the centre tingle, pull up, and fasten down with a tingle. Now cut the cap as previously done on the right-hand side. Take hold of the cap to the left of the knife cut, pull up, twist the pincers to the right, and fasten down with a tingle. Continue in this manner until the left-hand corner tingle is reached. Trim away the material which has "bunched up" on the insole, tap down, and the cap is lasted. Withdraw the rivet holding the middle sole, which place in position.

If the middle sole seems too short. cut through it from side to side, beginning the cut $\frac{1}{4}$ in. in from the edge, and finishing $\frac{1}{4}$ in. from the opposite edge. Now pull the toe portion of the middle sole firmly forwards, and it will yield sufficiently to cover the lasting. If the middle sole seems too narrow, make a cut from the front of the toe $\frac{1}{4}$ in. from the edge, and proceed towards the centre of the boot to the same distance as the toe-cap extends. Now, with the lasting pincers, pull the right side and fasten down with a tingle. Next pull the left side, and fasten down in the same way. The middle sole will be found by this method to yield a little more width. If the middle sole is too short and too narrow, adopt both cuts, making practically a cross cut, and proceed as detailed. Fasten the middle down with tingles, and the boot is ready for the sole. Use $\frac{3}{8}$-in. tingles for women's caps, and $\frac{1}{2}$-in. tingles for men's.

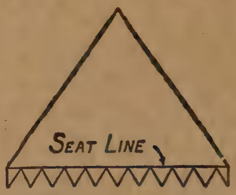


Fig. 10.—Lining Piece for Boot

BACK LINING

A frequent complaint in the wear of ladies' boots is that the linings at the back very soon become ragged. Here is a ready means of meeting this difficulty. Select a light chamois leather, cut a lining piece of a triangle shape (see Fig. 10), the base of the triangle being intended to be laid on the seat of the insole, and the apex of the triangle going to the top of the leg. Place in position outside the upper, mark off at the seat of the heel, and allow the triangle shaped piece of chamois to drop ½ in. below the seat of the upper. Then place the leather on the cutting board, and cut out pieces of a vandyke shape from the base edge, the cuts being ½ in. in depth—that is to say, extending from the edge to the seat line already marked on the material.

Apply rye-flour paste, and then fix the material in position on the inside of the boot. Turn down the base of the material, so far as the seat line, on the insole of the heel, which will be facilitated by the vandyke cutting, as previously described; then, working upwards from the seat, smooth the lining piece into position at the sides and leave to dry. When dry, take a stabbing awl, and bore through the lining piece and the upper from the inside, making the holes ⅛ in. from the edge of the material. The holes now formed, as shown on the outside of the upper, will make the stitching line. If no machine is in use the closing may be done by hand, using a light thread.

In the case of back-lining shoes, the lining piece (Fig. 11) will be cut out square. Cut out a light heel-sock and paste it on the heel of the insole.

ANKLE SUPPORTS

For ankle supports (see Fig. 12) select light, firm leather. Cut a piece 1 in. wide, and long enough to extend from the top of the boot leg to the lasting in the waist. Skive this down at all edges with a wide skive, as shown by the dotted lines in the illustration. Thin down the lower end very fine, so as to allow of lasting. Raise the waist of the boot, and release the lasting of the upper at the point in line with the ankle. Then insert the stiffener from the lasting side, between the upper and lining, and force the stiffener upwards until its top end reaches the top of the leg. The stiffener must be inserted with its flat or unskived side next to the upper, and the skived side next to the lining. Machine, or stab, a few stitches across the top of the leg through the stiffener, lining and upper. Place another row across, about half-way down the leg. Next force the lasting and stiffener snugly under the waist, and rivet the waist down.

If the boot is a welted one, and lasting the stiffener cannot be done, proceed as follows: After preparing the stiffener, release the binding stitches at the top of the leg, and force the stiffener down as far as it will go towards the lasting. Mark off the surplus length of the stiffener at the top of the leg, withdraw the stiffener, cut off its surplus length, and skive down the end. Re-insert the stiffener, stab a row across the top of the leg, through the stiffener, lining and upper, at the binding line, another row about half-way down the leg, and a further row low down at the lasting. Make sure that, in the bottom row, the stiffener receives the stitches. Then tap down gently, and the repair is finished.

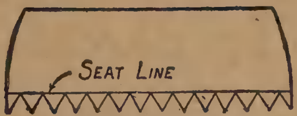


Fig. 11.—Lining Piece for Shoe

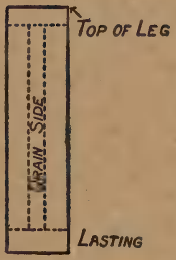


Fig. 12.—Ankle Support

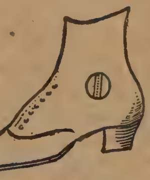


Fig. 13.—Marking for Ankle Patch

ANKLE PATCHES

Ankle leg patches (see Fig. 13) should always be placed underneath, between the leg and the lining. Cut the patch a circular pattern, place it on the leg upper covering the worn part, and mark round with a pencil. Next cut through the upper within the pencil mark across the diameter, force the patch underneath, and stitch round the inside pencil mark, and on each side of the cut. The dotted line in Fig. 13 shows the cutting mark to allow of inserting the patch between the leg and the lining.

MISCELLANEOUS RIVETED WORK

The small operations in riveted work that will come in the way of the home repairer are such as toe-piecing, side-piecing, and dealing with heel tips.

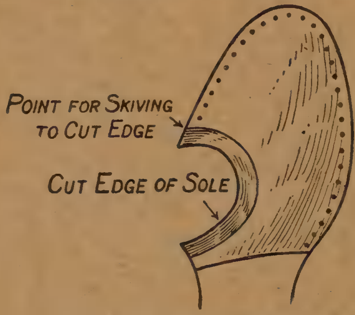


Fig. 14.—Side-piecing a Sole

Toe-piecing.—In toe-piecing, turn back the toe of the sole to an inch beyond the worn part. Hold the knife upright, and cut off the toe of the sole at its farthest worn part. If the sole is a riveted one, force out the rivets as far as the unworn sole is released. Mark across the sole at the rivet holes farthest back, and skive from this mark to the cut edge of the sole. Let the skive graduate to the thinness of a wafer at the cut edge. Then make a paper pattern of the toe from the beginning of the skiving. Cut out the toe-piece, leaving a little full, and mark on the flesh side of the toe-piece a distance equal to that skived on the old sole. Skive down from the mark on the edge gradually to a $\frac{1}{16}$-in. substance. Then damp the toe-piece and hammer on a flat-iron. Place the toe-piece in position, allowing the thin edge to just cover the beginning of the skiving on the old sole, and drive two rivets across this joint and one near the extreme end of the toe, to keep it in position. Then rivet round, hammer down, and "finish."

Side-piecing.—For side-piecing, lift the sole an inch on one side of the worn part, and remove the rivets if a riveted sole. From the rear rivet-hole at each side skive fairly deeply at the beginning and proceed towards the centre of the worn part for 1 in. inwards. Cut through the sole at this point on each side. Make a mark, beginning from the spot where last cut through the sole, inwards to the centre of the sole, working in a semicircle back to the spot where the first cut was made in the sole (see Fig. 14). See that this semicircle covers the whole of the worn part of the sole inwards. Hold the knife upright, and cut out the portion of the sole so marked. Now skive down the edge of the semicircle all the way round in line with the beginning of the skiving on the sole edge. Make the pattern of the side-piece, cut out, and skive all round the edge (excluding the edge to the outside of the sole) to a distance equal to the skiving on the old sole. Place in position, and fasten with two rivets placed on the ordinary riveting line. (A rivet placed in the centre of this side-piece would cause the piece to wear away quickly at that point.) Rivet round, placing the rivets on the inside edge about $\frac{1}{4}$ in. inwards, hammer down, and "finish" off as usual.

Fixing Iron Heel Tips.—In fixing iron heel tips, it is necessary to have the heel perfectly level, or the heel tip will spring in wear, though it may seem secure at the time of fixing. Having made the heel level, place the heel tip (Fig. 15), under-side upwards, on the instep part of the bottom of the last or hobbing foot, so that there is a space underneath a portion of the tip. Tap the tip gently between the plug holes, moving the tip so that there is a space underneath the part that is being tapped with the hammer. This will have the effect of slightly hollowing the tip, which will help it to bind to the heel when being fixed. Place the tip in position on the heel, and drive a plug (or tip nail) in the back hole, halfway down only. Now drive a plug in each hole at the corners, halfway down. Next drive the half-driven plug at the back right down flush with the heel tip. Do the same with the two corner plugs. Now drive in the rest of the plugs, which may be driven flush at the first time of driving.

A "filler" is now required for the space within the rim of the tip. Take a piece of scrap leather, of a substance equal to the thickness of the heel tip and near the size of the tip itself, lay this leather, grain downwards, on the tip and covering the cavity, then hammer the leather heavily, and the impression of the inner edge of the tip will be found on the grain side as shown in Fig. 16. Cut out this mark with a slanting cut inwards to the flesh side. The filler will then be found to fit exactly within the rim of the tip. Rivet the filler down with about half a dozen rivets round the edge, file the tip corners to prevent tearing of trousers or dress in wear, and proceed to "finish" the heel.

OTHER OPERATIONS

Cementing Leather Soles to Boots.—Leather soles may be solutioned on smooth-surface, light boots, such as pumps, in the following manner. Rasp the boot sole on the bottom so as to form a roughness, the slight grooves caused by the rasp forming minute receptacles for the solution. Rough-round the sole, and skive off all paste or loose flesh from the flesh side. Rough the surface with the rasp. Give the sole and the boot bottom each a coat of solution and leave to dry. Then apply a second coat, and afterwards a third. When the third coat of solution is dry, heat the boot and the sole at a gas light. Place quickly together in position and "bed down" the sole to the boot with the hand for a few moments, passing the hands rapidly over the whole surface of the sole. Drive a few long rivets round the edge at intervals, leaving sufficient of the rivets standing up to permit of their withdrawal afterwards. Now press the welt down to the sole edge, using the bone or welt-stick, going round the welt several times until it grips the sole. Leave to set thoroughly before drawing the rivets and "finishing off."

Repairing Worn Wooden Heels.—First strip off the top piece, and if the wooden heel is leather-covered, turn back the cover to below the worn part of the heel. Rest the back of the heel on the last, and force away the sole, which is continued from the waist up the front of the heel. Next rest the front, or breast, of the heel on the last, place an old knife on the back of the heel just below the lowest point of the worn part, then, holding the knife perfectly straight, tap smartly on the back of the knife-blade with the hammer, cutting away at one blow the whole of the worn part of the heel. If the heel does not chop quite straight, level it with a sharp knife. Now pull up the cover and lay it on the top of the heel and fasten down with a tingle at each corner and one at the back. Next build up the heel to the necessary height with leather lifts and top-piece. If the heel is an uncovered or painted one, the operation will simply consist of chopping and rebuilding as described.

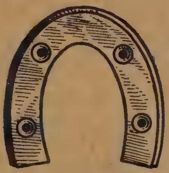


Fig. 15.—Heel Tip

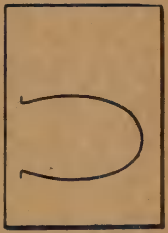


Fig. 16.—Marking-out Tip Filler

Repairing a Broken Waist.—This break usually occurs on the riveting line of the waist. Lift up the waist and remove the rivets from the waist line. Mark across the waist 1 in. from the waist edge to the joint, and remove all rivets within the line of marking at the sides. Next mark across the waist of the boot, 1 in. *below* the waist edge of the sole. Skive down the waist from the mark made, and then skive down the old sole within the mark. Cut a piece of very light substance sole leather to the shape of the boot waist, skive down all the edges, place in position on the boot waist, and rivet down.

Repairing Broken Heel Seat.—If the upper is unbroken, insert the lifting awl between the split lift and the first lift, and remove the heel whole. Cut a piece of light leather to the shape of the heel part of the insole, bringing its length halfway down the waist; fasten the insole piece into position on the insole with a couple of tingles driven in the waist. Then place the boot on the last, and drive long tingles or fine rivets through the split lift to reach the new insole piece in the inside of the boot. Next place the heel back into position, and fasten by driving long rivets from the top-piece. If the rivets are not long enough to reach the insole from the top-piece, the heel should be put back in two sections.

Fixing Rubber Top-piece.—Remove the top-piece and rasp the lift to make grooves for the reception of the solution, and scrape away the white substance on the under-side of the top-piece until the actual rubber shows clearly. Next beat up the edge of the top lift all round, so as to make the extreme edge form a kind of slightly raised rim. Apply solution to the lift and top-piece, and when dry, pass rapidly before a light until the solution is heated on the lift and top-piece, and place quickly in position. Hold the top-piece down with the hands for a moment to give time for the solution to grip. Then place the boot, with the last in, bottom downwards, so that the weight of the last is on the heel. When set, drive in top piece pins, if any.

Rebuilding Cuban-shaped Heel.—Remove the old heel, including split lift; cut out the new split lift, attach and round up square with the seat. Place the first new lift in position, and round up square with the split lift. Next attach the second lift, and round up with a very slightly inclined cut towards the top of the lift. Follow this method with the rest of the lifts to the top lift, placing the rivets well inwards. Knife up the heel to the required pitch, attach the top-piece, and round up square to the top lift.

Inserting Stiffeners.—Select a last that will well fit the boot. Lift off the heel from the split lift, remove the split lift, lift up the seat, and turn the seat and waist back to the joint. Drive a long rivet through the waist to the sole joint to keep the waist and seat held back. Release the lasting round the seat and down each side of the waist to the extent of the stiffener. Withdraw the old stiffener and take the boot from off the last. Use an old stiffener for a guide in shaping the new stiffener. Skive the stiffener edges, and place in position in the upper; then place the boot on the last, pulling the boot well forward to get the back of the upper close to the last. Last down the seat corners, using the crease made by previous lasting as a guide. Then pull over at the back and tingle down. Next proceed to last down, using the previous lasting crease as a guide. Place the seat and the waist of the outer sole back in position, rivet down, and tack on the split lift, leaving a little full. Then attach the heel with long rivets and beat up the seat.

Making a Split Lift.—Cut a strip of leather $\frac{5}{8}$ in. wide and long enough to go round the seat with a little to spare. Skive on the flesh side, beginning $\frac{1}{4}$ in. inwards from the edge and skiving down to a feather at the opposite edge. Wet the strip and allow to dry off until mellow. Now take hold of both corners of the strip, holding the ends close together in the left hand. Lay the leather on the lap-iron and tap down the skived part. As the pleats arise, tap them well down until the desired shape is obtained.

Riveting a Clump on a Welted Boot.—Fit the boot with a full-size last, and rasp the edge of the sole to reduce the substance. Mark round the sole for riveting in such a position that the rivets will be in line with the position of the inseam. Use short rivets, and rivet closer than in ordinary work. If long rivets are used, it will result in cutting the inseam; whilst if the inseam is missed in riveting, the long rivets will curl on the insole. It is advisable to place a piece of felt between the sole and the clump.

Nailed Work.—In hobbing a medium-fitting boot, mark for one row round the edge from joint to joint, and then one row on the outside joint. Next begin marking at the inside joint, and continue to just round the toe. Then mark for three rows up the boot centre, finishing in line with the toe-cap corners. In a wider-soled boot, place four rows up the centre. The same remarks apply to use of "cuts" or "brads."

The Use of "Fitter" Nails.—Fitters are the heavy oblong nails generally used in carters' or farmers' repairs; they are placed round the outside edge, and if properly placed they fit closely together, from which fact is derived the term "fitters." Drive in in the following manner: Put in the first nail with its widest side to the *outside* of the foot edge. Drive the next with its *narrow* side to the outside edge, then the next nail with its widest side outwards, and so on all round the edge. By this method the "fitters" will fit closely and squarely, as intended, whilst no difficulty will be found in keeping to the proper alignment whilst going round the toe.

Side-piecing and Toe-piecing Nailed Work. — Side-pieces or toe-pieces on heavy-nailed boots are best affixed in the following manner: Knock out the hobs on and round the affected part of the sole. Cut out a light-substance piece of sole leather and lay *on the top* of the worn part of the sole. Next, in nailing, use a smaller size of hob than is in the rest of the sole. By this method the heads of the smaller hobs will come nearly level with the heads of the larger hobs, thus making a level job, whilst at the same time the foundation of the boot will not be in any way disturbed. The reason for adopting this method is that in stripping a heavy-nailed sole the sole is apt to break between the nailing.

Sewing Soles on Veldtshoen.—Thin down the old sole very carefully, as if the skiving is done too deeply the upper will separate from the sole. Round up full, and put in the new stitches immediately behind the old ones. A good-fitting last must be previously inserted, as if the last is forced in after skiving, the sole and the upper will probably come apart; and if a narrower last is used than ought to be, the shoe will be "taken in" in the sewing.

In re-welting, fit the welt close to the old cut welt at the joint to the left hand. Place in position, and pull tightly round the last to the opposite joint. Do not cut the welt to fit here, but leave the cutting until the last stitch is put in previous to reaching the old welt. The welt is taken up in sewing, and if fitted close at both sides, the new welt will be found to be short when the last stitches are reached. Tack the welt in position at the joints, toe, and sides of the cap, and then sew.

Boot Tongue Slipping During Wear.—Discomfort is sometimes caused by the tongue of a laced boot slipping to the side during wear. A very simple plan to overcome this is as follows: Near the top of the tongue (about the third lace-hole from the top) sew a loop on the front. This can be done with an ordinary needle and thread, making, as it were, a single long stitch several times in the same needle holes. Let the stitch be left loose. When lacing up the boots, and this point in the lacing is reached, simply place the tags of the lace through the loop on the tongue before passing through the lace holes. It will then be impossible for the tongue to slip whilst the boot is being worn.

PUMP SOLE WORK

The stripping of a pump, or turn-shoe sole, is an operation requiring careful handling. The readiest and safest method is to insert a full-fitting last into the shoe, one that will hold the upper well up from the sole edge. Next, with the bone, force the sole edge away from the upper, and the stitches will be revealed. Cut the first stitch just so low down in the waist as it is intended to bring the new sole. As the turn-shoe is very flexible the sole should be brought well down into the waist, to provide against the graft breaking in wear, owing to the spring at that point. Cut the stitches round the sole to a point exactly opposite the first cut stitch, and cut straight across the sole with a square edge cut. Damp the sole, and gently hammer out. Next lay the sole leather on the cutting board, and the old sole on the top of it, the sole leather being grain side upwards, and the old sole flesh side down on the grain side of the sole leather. Drive a long rivet at the toe, through the old sole and the sole leather, and into the cutting board. Drive two rivets in a similar way at the waist, and mark round the edge and across the waist of the old sole, on the grain of the sole leather. This must be done very exact. Withdraw the rivets, and turn the new sole flesh side upwards. Note very carefully the width of the feather on the old sole, and mark the new sole for the feather at the same distance from the edge. Begin marking at the extreme waist corner, and finish at the other extreme waist corner. The various markings for preparing a pump sole are indicated in Fig. 17.

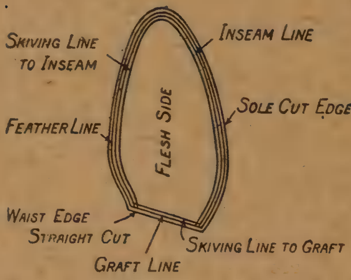


Fig. 17.—Preparation of Pump Sole

Now mark across the waist ¼ in. from the waist edge, and then, beginning on this line at the waist, mark round the sole ¼ in. inwards from the feather mark, finishing the marking on the waist line previously mentioned.

Now skive the sole outside the first marking, to make the feather, this skive being very slight, as the feather edge is also the sole edge. Hold the knife upright, the point on the beginning of the inner marking, and cut round on the marking with a downward movement. Next hold the knife flat on the sole bottom, with the point towards the inner marking just operated upon. Keep the point in this position, raise the knife handle slightly, and proceed to cut all round, letting the knife penetrate so far as the previous cutting, but not beyond it. Then remove the freed leather. Now operate in just the same manner on the line across the waist: a straight down cut on the line, and an angle cut inside the line, and remove the freed leather. The sole is thus provided with inseam and waist graft (see Figs. 17 and 18). Take the shoe, and cut three stitches on each side of the waist. Turn the waist back, mark across, and cut the graft exactly as done on the waist of the new sole. Tack the waist of the shoe down to the edge of the cutting board, graft side upwards; place the sole in position, with its waist edge to waist edge of old sole, very closely, and tack the sole down to the board. Then, beginning at the corner of the waist just inside the feather, sew through the two grafts, exactly as in sewing through the inseam and welt in hand-sewn work. Cross the threads at the last stitch over the grafts, and tie tightly together. Gently hammer down the knot.

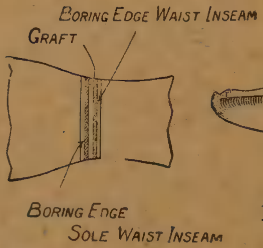


Fig. 8—Grafting the Waists

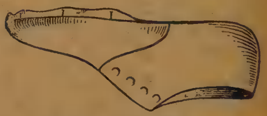


Fig. 19. — Front of Upper Pulled Over on Insole

Now turn the upper inside outwards; select a last the outline of the bottom of which should correspond as nearly as possible with the outline of the sole, and insert in the turned shoe. Fit the toe of the sole exactly with its edge level with the edge of the toe of the last, and drive a rivet through the sole toe into the last. Now pull the upper over at the toe, and fasten with a rivet through the exact toe centre of the upper to the feather of the toe of the insole at its centre. Take hold of the upper at the joints on each side, press the thumbs on the sole at the graft, and pull the upper and sole towards the heel, so that the upper fits snug to the last from the joint to the toe. Then rivet the sole down to the last at the joints, pull the upper over at each joint, and fasten down to the feather of the insole with rivets. Next pull the upper over at each side of the toe, and fasten. Fig. 19 shows the upper pulled over on the insole.

Turn the shoe round, with the toe next to the worker, and begin sewing at the left-hand side of the waist. Place the first stitch immediately behind the beginning of the cut stitches in the waist, sewing through the old inseam. through the same holes in the inseam and upper as made in the making of the shoe. On reaching the graft, pass over this and set the next stitch immediately in the graft corner. reaching the hole in the upper which is opposite to the space taken up by the graft. Insert the awl from the inseam side, exactly as in sewing in a welt piece, and bring the awl point out in the stitch hole of the upper made in making the shoe. Continue in this way round the shoe. until the opposite joint is reached.

Take up the stitch hole in the upper opposite the graft by inserting the awl in the immediate graft corner. Pass over the graft, and place the next stitch in the immediate graft corner on the old waist. The stitch must be pulled up very tightly at the graft corners. Finish sewing a stitch beyond the farthest cut stitch in old waist, withdraw all the rivets, and remove the shoe from the last.

To turn the shoe back, hold the edges of the quarters with the thumbs and fore-fingers, press the toe upper inwards and the vamps outwards. When turned replace the last tap down the graft, and place on one side to dry. When dry, take out the last, replace the packing and sock, pasting them in.

If the shoe has a pasted toe—that is, the toe lining hardened with a paste to act as puff—the paste should be damped by wetting the lining at the toe, when the upper will keep to shape more easily.

A six-cord thread will usually be heavy enough for this class of work, and the most suitable awl will be one with only a slight shoulder curve. Ornaments on shoe fronts should always be removed before stripping the shoe.

The first sole stripped should be used as a guide for distance in cutting off the second sole; but in cutting out the new soles, each should be cut to the exact pattern of each old sole.

In the case of a pump shoe having a waist too weak to permit of grafting, the waist may be tingled in the following manner: Cut the sole $\frac{1}{2}$ in. longer in the waist than the old sole, and mark off the extra distance on the flesh side. Mark an equal distance on the old waist from the cut edge and skive the sole waist from the mark to the edge. Then mark round the sole for the inseam and feather. beginning from the skiving line, and finishing at the skiving line at the opposite side. There will not. of course, be any marking for the graft. Next skive the old waist from the mark to the cut edge. Place the sole in position before turning the upper, just as in ordinary repairs, and tingle across the waist, cutting off the heads of the tingles. Turn and proceed as previously described.

When the sewing is completed, sew down the skived cut edge of the old waist (which will be loose) to the sole, using a light thread and overcast stitch, to prevent the waist edge from curling during wear.

Sewing a Clump Sole on a Pump Shoe.—The edge of the old sole should be trimmed carefully, and the new sole should be rounded up full. The stitches ought to be set well back in the " welt " of the old sole. After the sole is sewn on, the piece should be taken out of the welt to a feather, so that by rubbing well with the bone or welt-stick the feathered edge of the old sole may be moulded down to the new sole, allowing of the finishing of the edge to appear light. A clump sole can only be sewn on to a well-made pump shoe—that is, a pump shoe which has a good inseam and is well sewn—as the stitches of the old sole have to carry the new sole. The only method to make a safe operation in a similar repair on a cheap or flimsy pump is to place loop stitches round the upper from joint to joint, and to sew the sole through the stitches and the old sole edge.

Riveting a Sole on a Pump Shoe.—This is frequently done when the price of "pumping" is objected to. Remove the sock and packing from inside the shoe, and cut an insole from a very light split exactly to the pattern of the sock. Place in the shoe and dextrine it down, allowing it to dry. Next tack on the sole, rounding up full. "Rivet" round with tingles, and leave the heads of the tingles upstanding. Next cut off all the tingle heads and hammer down. Then dextrine the packing and sock back into position in the shoe. Take the bit well out of the welt when finishing, and finish the edge a little full. This is the neatest way of doing this repair, and the tingles will hold more securely than rivets.

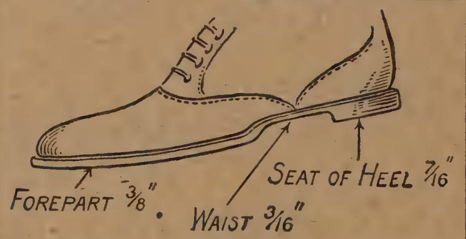


Fig. 20.—"Heel-less" Rubber Bottom

RENEWING RUBBER SOLES OF SPORTS BOOTS, ETC.

There are two styles of rubber bottoms—with heel, and without. In the bottom without heel (Fig. 20), the heel is defined by a slightly increased substance.

In purchasing rubber bottoms, corrugated rubber should be avoided, as also the grey rubber. The correct rubber bottom is red in colour, and the surface is perfectly smooth, without markings of any kind. The substance selected should be $\frac{3}{8}$ in., measured at the substance of the forepart.

In taking a pattern for the sole (if the old rubber sole is too far gone to be used as a pattern), a little extra should be allowed in width and length, so as to permit of the rubber being "bedded over" at the edges when fixing. If the right quality of sole is obtained, the surplus rubber can be easily pared up to the welt after fixing.

To fix the rubber sole proceed as follows: Insert a wooden last to fit fairly well in the boot. If the old sole is solutioned on only, after removing the sole, scrape the welt on the side to which the rubber has been attached, so as to remove all traces of the old solution.

Some rubber soles are sewn as well as solutioned, a stout thread and a long stitch being employed. In this case, with the point of a sharp knife cut each stitch on the welt side. The removal of the sole will then bring away the stitches from the welt leaving the stitch holes perfectly clear. Next, from the under-side of the new rubber sole, scrape away all the composition until the raw rubber shows up. Mark all round the edge as far in as will be taken up by the welt. Within this marking, roughen the rubber with the point of a sewing awl. until a result is obtained something like the appearance of the surface of a rasp. The little "cells" thus made will collect the solution, and greatly help in obtaining a firm grip. The next item is the preparing of a suitable solution, and a hot one will be best.

Obtain some gutta-percha of what is termed the "tissue" variety. Roll this "tissue" into a rope, and cut off slices sufficient to half fill the inner vessel of a glue-pot. Place the gutta-percha in the vessel, and cover with benzoline or petrol.

Allow to remain in a warm place not near an open flame until the gutta-percha has dissolved. This preparation is highly inflammable and gives off an inflammable vapour. Try the liquid by dipping a stick in the vessel.

For the first coat a thin solution will be required. If the liquid does not run off the stick freely, add a little more benzoline. Next, with a small brush, give the welt of the boot a coat of the thin solution, and apply the same also to the rubber sole on the portion marked off and roughened. The welt should dry up grey; but if no colour shows up when dry, again apply the thin solution.

Now add a little more gutta-percha to the liquid in the vessel, and boil up afresh. When dissolved, try its consistency with the stick. At this stage the liquid should be thick enough to run off the stick only very slowly; it should, in fact, almost cling to the stick. Next, with a piece of stick previously thinned down at the end with a slight scoop or hollow, apply a heavy coating all over the bottom of the rubber sole. See that the extreme edge of the rubber is well covered. Apply a coat to the welt, also seeing that the residue of the solution goes to the edge of the welt; when dry, pass the boot and the rubber sole alternately quickly backwards and forwards over a lighted gas-jet. As soon as it is noticed that the coat of solution on both the rubber and welt is dissolved, press both firmly together.

Particular care must be taken to have the sole in its exact position, for this operation must be done very quickly, and should the sole be moved after the coats of solution on the welt and rubber have once met, the result is sure to be an insecure joining. As soon as placed together, proceed as follows: Rest the boot between the knees, and whilst "bedding down" the waist with the left hand, bed down the toe and heel alternately with the right hand, smoothing down the sides when passing from the toe to the heel. Drive a long rivet through the rubber to the last at the toe (to be afterwards withdrawn), one at each heel corner, one at the extreme back of the heel, two at each side of the waist, and one at each joint as quickly as possible.

The next operation is forcing the *welt* to the rubber. A wheel is required for this purpose, and a close-cut fudge-wheel will answer, provided it is wide enough to completely cover the welt and a little over. Run this wheel quickly all round the welt, using pressure, and follow up the movement of the wheel by pressing the rubber towards the welt with the left hand. It will be necessary to wheel round the welt continuously until the solution binds at all points. Then place the boot on one side for several hours to allow to thoroughly set. Do not attempt to clean away any solution from the edges until the boot is dry, as this residue of solution covering the joining outside the edge will assist the binding. When dry, pare up close to the welt with a sharp knife and glasspaper the edge.

Sewing Rubber Soles.—If the boot has previously had a rubber sole sewn as well as solutioned, proceed as follows: Heat a knitting needle in the gas-jet, and force it through the old stitching holes in the welt, and through the rubber sole. When all holes have been pierced, trace the point of the hot needle lightly between each hole made on the bottom of the rubber sole. This will make a kind of channel for the thread.

Having prepared the sewing thread of stout substance, instead of attaching bristles, fix a slightly curved saddler's needle to each end of the thread. Proceed to put in the stitches as in sewing on an ordinary sole; but the threads must be pulled up very gently on the rubber side. The holes previously made in the rubber will help the passage of the needles. It will be useless to attempt the sewing with bristles, as the rubber closes up when the borer is withdrawn.

It is a good plan, even in soling what has been a plain-solutioned bottom, to put in a few stitches at the toe and at the extreme back of the heel. In this case, before using a hot needle to bore the rubber, holes will have to be made from the welt side with the sewing awl. It is also another good plan to use gum arabic for "waxing" the thread instead of wax.

Repairing Rubber Heels.—Rubber bottoms with heels, such as ladies' tennis shoes, may have the heels repaired in the following way: With a sharp knife cut away the heel until level with the lowest part of the worn portion; then clean, and roughen up by rasping. Take a pattern of the heel, and purchase a pair of stationary rubber heel pads (Fig. 21), a size larger than the pattern. Most of these pads have holes for the reception of rivets; but there are plain pads to be obtained, and this will be the style required. Scrape away the composition from the under-side of the pad, and apply solution of a consistency that runs slowly off the stick. Apply to the heel and the pad, covering the whole surface of each, and then proceed to attach as described for the sole, excepting that rivets for holding the work until dry are not necessary.

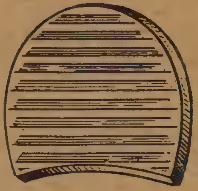


Fig. 21.—Stationary Pad for Tennis Shoes

Finishing Edges of Rubber Soles.—In finishing the edges of rubber soles, they should be pared up closely, well glasspapered, and left at that. The application of a finishing liquid to the edge might cause the rubber to "perish."

REPAIRING RUNNING SHOES

The running shoe is made on the "pump" or turn-shoe principle; but it has an outside clump sole sewn on.

To re-sole, pass the knife round the clump between the pump sole and the under-side of the clump. Use the old clump as a pattern for the new sole. After cutting out the new sole, lay it flesh side down on the cutting board, and place the old sole on the top of the new, flesh side next to the new sole. See that the edges of both soles are square in position. Now mark through the spike holes in the old sole to the new for the positions of the spikes. Having marked for each spike, bore through the markings with a strong sewing awl. Next lay a spike on the board, point upwards, and place the new sole flesh side down on the spike point, so that the point of the spike enters one of the holes previously made. Now tap the leather with the hammer all round the hole on the grain side, and the spike will work through the material. By this method a tight fit is obtained for the spike, and it is not so likely to work loose in wear as it would be if the holes were punched.

After fixing all the spikes in this way, tack on the sole and proceed to channel. The channel should be made a little way in from the edge, as the welt of the shoe is close to the upper. The channel must be continued also across the waist of the new sole. Use a seven-cord thread and a curved awl in sewing on the sole, and sew eight stitches to the inch. To sew the waist, bore through the channel to the inside of the shoe, beginning at the joint corner. Insert the bristle, pull the thread half-way through, and bore again $\frac{1}{4}$ in. farther along. Insert the bristle from the inside with the left hand, then insert the right-hand bristle in the channel. Pull up the stitch, and proceed in this way until the waist is sewn in. Lay the channel, and finish, edge only, in the usual way.

Owing to the running pump having to carry the weight of the outside clump and spikes, it often happens that the pump stitches give way. When the upper breaks away in this manner proceed as follows: Turn the pump inside out; this is easily accomplished on account of the upper being low cut. Bore through the ridge or inseam, which will be seen on the sole, allowing the point of the awl to pass through the stitch hole in the edge of the upper. Insert the bristle from the insole side and through the upper edge, and pull half the length of thread through. Next insert the sewing awl at the inseam in a position opposite to the next stitch hole in the upper edge. Insert the left-hand bristle first from the upper side, then the right-hand bristle from the inseam side, and pull up the stitch. Proceed in this way until the break is repaired, finishing sewing a couple of stitches beyond the break, and turn the shoe back again.

REPAIRING CRICKET BOOTS

The bottoming material usually employed in cricket boots is either chrome tanned leather or Johnston leather. These are flexible, light, and damp-resisting.

In re-soling a leather-bottomed cricket boot, the outer sole should be turned back to half-way between the joint and the heel, and at this point make a straight cut. Mark ½ in. behind the cut, and, holding the knife upright, pierce half-way through the substance of the leather. Next place the knife at the cut edge at the middle of its substance, and cut through with a level cut towards the point where the leather has been pierced at the marking. The freed leather can now be removed, leaving a flange for the reception of the waist of the new sole.

In preparing the waist of the new sole, mark off from the waist edge a distance equal to the flange in the waist of the boot. Reduce the substance of the portion thus marked, so that it will rest on the flange to give a level joint. Rivet closely across the waist, and see that the rivets are just long enough to touch the last, and clinch. This is necessary on account of the strain a cricket boot is put to, and if the rivets are not clinched, the waist will "spring." Also, a perfectly level bottom is necessary, and the "letting in" of the waist as described will accomplish this desirability.

Cricket boots that are "heel-less," that is to say, level on the bottom from heel to toe, are raised at the heel by means of what is termed an inclined lift (see Fig. 22). This takes the place of top-piece and lifts in ordinary boots. The "inclined lift" is skived down at the "breast" (that is, the part of the lift which will be placed towards the waist of the boot), in just the same way as the waist of a new half-sole is skived in ordinary soling. If the heel portion of the sole is not actually worn through, it should be lifted up, the inclined lift inserted, and the seat riveted down again. In such a case, however, the inclined lift should be only of a substance equal to that by which the heel of the sole has been reduced in wear. If the heel portion is worn right through, the inclined lift should not be skived to a feather, but should be treated exactly as described for the sole. The lift should then be placed on the heel, and the heel marked off at the "breast" of the lift. Remove the lift, and mark again on the heel ½ in. nearer the back of the heel. Cut off here with a straight cut; then cut to the farther mark to form a flange as described for the sole, the heel thus being prepared perfectly level.

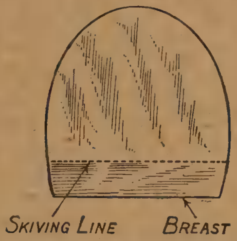


Fig. 22.—Inclined Lift for Chrome Bottom of Cricket Boot

In finishing the edges of boots repaired with chrome or Johnston leather, it is not advisable to set the edges with the hot irons, as this brings up the grease. Rasp and scrape, and glasspaper the edge well. Next apply a coating of gum arabic to the edge, allow to dry, and then, with a piece of hard cloth wrapped tightly round the thumb, rub the edge.

Repairing Football Boots.—Whilst chrome-tanned leather is most suitable for the soles of football boots, the studs (bars are now obsolete) should be cut from hard, stout bend leather by means of a sixpenny punch. Should bars be particularly required (they are not as a rule allowable) they should not be attached by means of a row of rivets, as this interferes with the flexibility of the boot. A rivet at each end and two close together at the centre will be quite enough.

Colouring Various Metals

A SELECTION of the best and most reliable methods of colouring metals will be given in detail in this chapter.

COLOURING BRASS

Brass may be so manipulated by varying methods that any of the following beautiful finishes may be given to it: black, verde antique, green, gun-metal. and any of the finishes that may be applied to copper (see a later page) may equally well be applied to brass, by first giving the brass article a flashing of copper in the plating bath. Methods of electro-plating are dealt with elsewhere in this work.

Black Nickelling.—Black finishes are equally applicable to copper as to brass. The first method to be described is that known as black nickelling. It is a method in which, by the use of suitable solutions, the nickel deposit, instead of being of a white appearance, has an intense black colour. The finish is capable of receiving a high polish, and is much less oxidisable than any other method yet tried. It does not present any insuperable difficulty, since any good electro-plater can readily get the black nickel deposit, providing the bath is properly made and carefully used. When the article has been black nickelled it may be buffed equally with the white nickel, and the deposit adheres most tenaciously to the baser metal on which it has been deposited.

The chemicals used in the bath and the order in which they should be dissolved are as follows: Take 12 oz. of the double salt of nickel and ammonia as commercially sold, and dissolve it in 1 gal. of water. Next add 3 oz. of sulphocyanide of potash, and then 2 oz. of carbonate of copper. Make a second solution by taking sufficient water and carbonate of ammonia, and add 2 oz. of white arsenic, which should previously be pounded to a fine powder. The strength as tested with a Beaumé hydrometer should be 6½°. By the aid of a gentle heat dissolve the arsenic. On no account boil the solution, since the arsenic will very readily volatilise, and thus be lost. The resulting solution should be quite clear, and it may now be added to the first prepared solution.

In using this bath the same conditions must be applied as in ordinary nickel-plating. The work must be absolutely free from grease, and to ensure this the articles should be dipped in the potash bath, and afterwards well rinsed before placing in the nickel bath. It is very essential, also, that the article should be as perfect as possible before plating, because any imperfection in the surface will be shown up more prominently under the black deposit. The articles being blacked may be coated by the basket method, which simplifies matters considerably; but large work must be wired, as is usual in plating. When the articles have received their necessary coating of black, they must be rapidly swilled in clean water and dried in hot sawdust. As previously stated, the blackness of the deposit is governed by the quantity of arsenic in the solution; if this is of the proper strength, the colour of the deposit will be of an intense velvety black. The operator must find out by a few first trials the quantities to be used, adding a little of the arsenic solution at a time till the result is correct. The anodes to be used for black-plating are the same as are used for ordinary nickel-plating, the black result being due to the arsenic of the bath.

The black deposit of nickel may be applied equally to iron, steel, copper, or german silver, while it is now extensively used to produce that delicate finish on silver goods known as the french grey finish, in which the high tones and shadows are afterwards obtained by a judicious use of powdered pumicestone and water. This treatment will be dealt with later on, with reference to silver finishing. In all nickel deposits, and in particular the black one, it is very necessary to see that the anodes are kept perfectly clean and free from the deposits which gradually form on them when in use. They should be cleaned about once a month at least, or otherwise the action of the anodes will be very tardy. If the anodes are to be used for white nickelling, they must be well scoured, so that the arsenic from the black depositing bath may not contaminate the ordinary white depositing bath.

Gun-metal Finish.—Prepare a solution as follows: Iron, preferably in the form of fine iron wire, which can readily be obtained, is dissolved in hydrochloric acid till the acid is saturated. If iron wire is not at hand, thin sheet iron may be used. The iron should be placed in a stone crock and covered with the commercial hydrochloric acid, afterwards adding one half as much water as acid. The crock may be warmed by any suitable means, in order to hasten on the solution. On leaving the solution to cool, a quantity of the iron will separate out as green-coloured crystals, and this is evidence that the solution is of a concentrated strength. To every quart of the solution add ½ oz. of white arsenic. This arsenic must be thoroughly powdered, and then added direct to the solution. Heat the solution with a gentle heat, and with constant stirring assist the arsenic to dissolve. On no account must the solution be overheated, or else the arsenic will most probably volatilise, and thus be lost. If on cooling there is any sign of crystals forming, a little water must be added in order to re-dissolve the crystals. Filter the solution through any good medium, such as a piece of flannel or some cotton-wool in a funnel. Test the solution, which should register about 30° Beaumé. The solution is now correct, and of sufficient concentration for the purpose, and when filtered should present a dark green colour and be quite clear.

To obtain the best results, prepare the articles by first giving them a fine matt surface, preferably by sand-blasting; but care must be taken that the articles are not fingered, as every finger-mark will show. If this is not applicable, then give a good scratch-brushing, and so impart a fine, satiny appearance. The deposit is applied electrically, and the strength to use is about 6 volts. The current should be put on first before lowering the articles into the bath, so that an even tone throughout may result, as the colour comes up immediately. Do not allow the articles to remain too long in the bath. Here discretion will be needed, since if the article has to be relieved, only a flashing will be required, although in ordinary circumstances a few minutes will be needed. There are two anodes that may be used for this work, namely a carbon or a nickel one. If a nickel anode is used, the deposit will be much harder, and will withstand much greater wear and tear; but it will be necessary to add a little nickel chloride to the bath, though not too much. After giving the deposit, remove the object and rinse well in hot water; afterwards dry in hot sawdust, and scratch-brush till the required shade is obtained. Then cover with a coating of

Zapon or transparent lacquer, in which a little nigrosin or aniline black has been dissolved.

Verde Antique.—The verde antique finish, which in old practice was obtained by means of a corrosive solution, was found too slow for ordinary commercial and manufacturing purposes, and particularly when cost became a factor, so that it became necessary to adopt a cheaper and more expeditious method. The following has been used for a large variety of ordinary cheap-priced goods. The object to be finished in the verde antique style is first sand-blasted in order to produce a fine matt surface, and one on which the colour could more readily take effect, and thus give a more successful result. After sand-blasting, the articles are well brushed over with a dry colour in fine powder form, such as paris green, chrome green, or brunswick green. Afterwards dip the article in a clear, colourless lacquer, such as Zapon. By this method it is possible to obtain almost any shade desired, the one thing needful being to remember that the finished colour is usually a shade lighter than the dry colour itself before being put on. This is a very cheap method, and gives uniformly good results.

Crystallising.—A very pleasing effect may readily be given to cast-brass objects—namely, crystallising the surface. It is difficult to give this appearance to rolled brass, since by rolling the crystalline structure of the metal has been removed; but with cast-brass articles, with all their natural crystalline formation, the crystalline structure is readily brought out. The articles require to be polished and practically finished. After buffing, they should be placed in the lye bath to remove grease, and then placed in the crystallising bath. This bath consists of ¼ gal. concentrated hydrochloric acid, 8 oz. of bichromate of potash crystals, and 1 gal. of water. The potash is dissolved in hot water, and the acid afterwards added. The solution may be used either hot or cold as desired. The results are in each case invariably the same. It usually takes about thirty minutes to obtain a good finish, using the solution cold. The one main consideration is to use a brass which naturally has large crystals. Such a brass is the ordinary common yellow mixture, and which is poured at a good heat. If the metal be poured at a low heat, the crystals are small, and do not finish well. After dipping in the solution, remove the articles and rinse in cold water. Then dip in a hot cyanide of potassium bath. Again rinse in hot water and dry. The surface of the metal must then be properly lacquered.

The general effect may be greatly enhanced by using suitable lacquers. A golden-coloured lacquer answers excellently, but a tinted lacquer also gives very good results.

COLOURING COPPER

There are a number of finishes which are applied to copper goods commercially among the most important being the royal copper finish and the black finish. Copper finishes are applicable to brass if this is lightly coated with copper, and many of the brass finishes are equally good for copper.

Royal Copper.—This finish, which is extensively applied to articles of an artistic and ornamental nature, is of an exceedingly beautiful colour. It has been copied for cheap work, but the finish can easily be detected when one has seen the true colour, which has been properly applied and finished off in a satisfactory manner. The finished article presents a deep cherry red colour of an excellent lustre, and, in fact, has the general appearance of being an enamel finish. No imitation can possibly come up to the real finish, although several have from time to time been tried, notably the skilfully coloured red lacquer finish. The royal copper finish being a metallic finish—that is, it is one due to an oxidation of the metal itself—it follows that it will be of a most durable nature, the oxidation of the metal being due to the chemical means adopted to bring about the desired result. So far there is only one objection that can be raised against it, and it is that no article which is soldered (that is, soft soldered) or that is required to be finished with a hard finish, can be coloured by this means.

Nitre Method.—One of the best methods of producing the royal copper result will now be described. It is known as the nitre method, because the chemical used to produce the result is saltpetre or nitre. It is a well-known fact that nitre has a strong oxidising action on copper, and is very rapid in its action. The article should be of copper, or heavily plated with copper. The saltpetre to be used is that sold in the crystal form, similar to soda. It requires to be melted in an iron pot or kettle, and the articles to be coloured are dipped into the molten saltpetre and allowed to remain for a few seconds until the oxidisation is complete. The principle is similar to annealing, except that the oxide in annealing readily scales off, while in the former case it is exceedingly durable.

On removing the dipped articles from the nitre bath they must be dipped into a bath of oil, preferably a high flash-point petroleum. This prevents the staining of the finished article. The proper heat at which the nitre works is about 1,100° F. If the nitre is allowed to boil, the action, instead of forming the red oxide, will form the black oxide, and thus spoil the finished article. As the heat is a very important item indeed in this finish, it is well, as a rule, to first dip one or more small pieces of copper in the bath before proceeding to finish the work in bulk. Gas is about the best means to adopt to ensure a uniform heat. A good bunsen arrangement forms an ideal heating means. The article, after being in the nitre bath, is placed in the oil bath to cool, and is then wiped over with a soft cloth and gently buffed. It only requires to be lacquered with a clear, transparent, and hard lacquer.

This method is suitable for all classes of small goods, such as buckles, match-boxes, cigar and cigarette cases, buttons, and similar small goods.

Oxidising.—The almost exclusively worked method of producing the oxidised finish is by means of liver of sulphur. Care must be taken with this operation, or good results cannot be expected. The bath or solution for the process is composed of 3 oz. of liver of sulphur dissolved in 1 gal. of water and used cold, when the deposit is more adherent. The article must be thoroughly clean, and the liver of sulphur should be fresh. The solution, if the liver of sulphur is correct, will be of a yellow colour. It deteriorates, however, after a time, and it is thus very necessary to test the chemicals first before making up any quantity of solution. This deterioration frequently is the cause of bad results, and is sometimes quite overlooked. If the finished article has to be shaded, it can be carefully touched up with a fine scratch-brush, so as to remove some of the surface colour, and afterwards lacquered with a clear, transparent lacquer.

Verde Antique.—The verde antique or old green finish is one of the most pleasing finishes that can be applied to copper ware. It is formed as the product of corrosion, and has taken its name from this result as the production of the action of the atmosphere after being allowed to act on the article for a time. Articles of copper and rich copper alloys, such as bronze coins, after lying in the ground for a time, become coated with a green deposit. In many cases this has been the result of years of corrosion. Articles of bronze or copper when allowed to remain under the action of sea air or moist-laden salt air are very quick to corrode, and consequently put on a green patina within a very short time. This green coloration may be put on by two methods, the one being a simple chemical dip, while the second is the corrosion method, and one which gives excellent results when carefully done.

First Method.—To make the solution for the first process, take of acetic acid 20 oz., nitrate of copper 2 oz., hydrochloric acid 1 oz., and sal-ammoniac ½ oz., and dissolve. This solution must be used hot. The article should be thoroughly clean and free from grease, and should be immersed for a few moments in the hot solution, and then allowed to dry.

It must not be rinsed. The action of the solution will give a dark green colour to the metal. If the article has been polished, the smooth texture will not be removed at all, showing that the action of the solution has not been a corrosive one, but simply a coloration by dipping. After standing, however, a gradual corrosion begins to take place. The colour is fixed with a clear lacquer.

Second Method.—A second method, and one which is fairly quick and gives good results, is obtained by mixing 2 oz. of acetic acid, 2 oz. of hydrochloric acid, and 100 oz. of water. Take a quantity of sawdust, and saturate it with the solution, taking care that the sawdust be not over-saturated, but just nicely damped. Place the articles, which have been thoroughly cleaned, in this damp sawdust, and leave overnight. Usually it will be found that the corrosion has uniformly covered the article with a green sediment. The articles now must be dried at a gentle heat, and may then be gently relieved, if desired, with a dry wheel. If the corrosion has entered deeply into the metal, the relief may require to be done with a hard scratch-brush. Afterwards lacquer the articles with a transparent lacquer. The corrosive effect may be heightened by adding a small quantity of broken chalk or limestone to the sawdust. This with the acetic acid gives off carbonic acid and this gas, aiding the chemicals already named, very much enhances the finished effect.

COLOURING SILVER AND SILVER-PLATE

Platinum Oxidising.—In this method no electric current is needed, the solution being applied to the article either by dipping, or, as is more generally the case, by means of a camel-hair brush, the article being then allowed to dry thoroughly. The coats to be applied may be one or more, as is considered desirable. The colour of the article when covered with the solution and dried is a dead black, very tenacious, and one to withstand the action of those washes which may at any time be used for cleaning purposes.

The solution to be used for this purpose may be made in several ways, two of which will be given. Take some platinum chips, bits of thin sheet platinum, say 50 gr., and dissolve in a little aqua regia, composed of 1 part strong nitric acid and 3 parts strong hydrochloric acid. When the solution is effected, gently evaporate down till it becomes of the consistency of syrup. At this stage add clean water, making the total bulk of solution 14½ liquid oz. This will give a solution equal in strength to 1 per cent. platinum. If a quick-drying solution is needed, instead of using all water to make the solution, part may be water and part alcohol. In the preparation of the article for oxidising, all grease must be thoroughly removed, preferably in the potash bath; and after cleaning, the article must be scratch-brushed. The platinum solution is then applied, if a small article, by dipping, and if a large article by brushing on. When using the solution as a dip, it will assist the operation by warming the solution, in addition to being more economical. If the brush is being used, the solution may be used cold, and the article dried in a gentle heat afterwards.

When dry, if the colour is considered satisfactory, the article may be relieved by means of a little powdered pumicestone and water, using either a soft brush or a clean rag. This will tone down the black colour, and bring out the beautiful effects of light and shadow. In using this solution, the water and pumicestone used for the finishing operation must be carefully preserved, since the platinum may be taken out of the water, and by other chemical means may be utilised to make a further supply.

If the use of platinum is too expensive, a solution may be made by using equal parts of platinum and pure iron wire, proceeding in exactly the same way as directed for the manufacture of the platinum solution first named. After the finishing process of relieving, coat the article with a transparent lacquer.

The second method of making the solution of platinum is with a small quantity of platinum bichloride, diluting either with water only or with water and alcohol as first named.

Oxidising with Liver of Sulphur.—This is a much cheaper method. In this case the deposit of silver, if the article is of a plated description, must be heavy, since the sulphur will unite with the silver; and if only a light dip is used, the silver will be completely removed in the after operation of buffing to produce the high lights and shadows.

In oxidising by the sulphur solution, it is well to use a weak solution, say 20 dwt. of liver of sulphur to 1 gal. of water. The article must be thoroughly clean and free from grease. On dipping it into the sulphur solution, the surface immediately turns a black colour, as previously stated, due to the formation of silver sulphide, which is black. The surface is next worked up by means of powdered pumicestone and water, using a soft brush to manipulate the mixture. If the article is of base metal, and has only had a very light dip of silver put on it, then the following method may be adopted. It is a method largely used in commercial works where cheapness is a main consideration. In this case, after the article has had the light coat of silver deposited on it in the usual manner, a flash of copper is deposited in the cyanide copper bath. Only the merest blush of copper must be used, since a heavy deposit will quite spoil the work. The article is now oxidised in a cold solution of liver of sulphur, being allowed to remain just sufficiently long to produce a black colour. The surface can now readily be relieved in the usual manner, since the copper will have been replaced by the black sulphide of copper, which is easily removed. The finished article should have a coat of transparent lacquer to prevent soiling.

COLOURING STEEL AND IRON

Deep Black Oxidising.—There are many articles now appearing on the market which have been oxidised a deep black of a very lustrous description. There are several methods which may be adopted for this purpose. The following one, which is applied by means of the electric current, gives excellent results and does not entail any great expense. The main ingredient used in the bath is nitrate of lead. The deposit which is found on the article is a deposit of lead, not in a metallic form, but as an oxide known as peroxide of lead. The lead is deposited on the anode, while a plate of lead answers the purpose of the cathode. The layer of peroxide of lead adheres very tenaciously to the article, which can readily be buffed without damaging the surface.

The solution which is used for the bath is made in the following manner: To 1 gal. of water is added $\frac{3}{4}$ lb. of lead nitrate and $\frac{1}{2}$ lb. of ammonium nitrate. When dissolved, the solution should stand at about 10° Beaumé. The water must be heated in order to dissolve the lead nitrate, since lead nitrate is only slowly soluble in the cold water. The solution will also require to be used hot if good results are to follow. The steel articles (or iron, if iron is being used) are freed from grease in the potash solution, and afterwards well swilled. The articles must be suspended on iron wire, and on no account must copper be used, since the copper will dissolve, and thus deposit on the iron articles. After well swilling the articles, they are connected up as the anode. This must be particularly noted, since the usual practice is to string the articles up to form the cathodes. However, in this case, the deposit takes place on the anode. For the cathode, take a plate of suitable size and the thickness of sheet lead. This will not then contaminate the solution of the bath. The amount of pressure to be used for the deposit runs from 3 volts to 4 volts. The articles, as soon as the current is applied, assume an iridescent tone, which, as the lead deposit thickens, gradually turns to a deep purple, and finally to black. As soon as the appearance all over is black, remove the articles from the bath, well swill in clean water, and dry out in warm sawdust. As previously stated, this deposit is extremely tenacious; in fact, it can readily be buffed without interfering with its finished condition; it may also be scratch-brushed, or even tumbled in the barrel.

This finish is equally applicable to nickel articles, since nickel forms the same conditions in the bath as iron or steel does. If, however, copper or brass articles are required to be treated with this black finish, it will be necessary to give them a fairly heavy coat of nickel. In this method the solution is not strengthened, as in copper-plating and similar work, by the gradual solution of the anode, so that it becomes imperative that the strength of the bath should be replenished from time to time by the addition of fresh supplies of lead nitrate. As a fairly large quantity was used in the first preparation, it is not necessary to replenish for a time after the bath has been in use.

Black Nickelling.—Another method of putting the deep black finish on iron and steel is by means of the black nickel deposit. This is accomplished by means of the electric current, and a solution made up as follows: To 1 gal. of water add 12 oz. of the double salts of nickel and ammonia as sold commercially. This can readily be done by means of a little warmth. Next add 3 oz. of sulphocyanide of potash and 2 oz. of carbonate of copper. Next take 2 oz. of white arsenic, and powder the same, since arsenic is somewhat difficult to dissolve, and add sufficient carbonate of ammonia and a little water to dissolve. The solution may be assisted by making slightly warm, say lukewarm, as this will not alter the ammonia. It must be constantly stirred, when it will become quite clear. When all is dissolved, add the arsenic solution to the main solution, stirring briskly till all is thoroughly mixed up together. The arsenic in the bath, while mainly instrumental in giving the black colour, does not apparently waste away, so that the bath will not need the further addition of any arsenic for some time. The strength of the solution is about 6½° Beaumé. It will be necessary to add from time to time some of the double salts of nickel and ammonia, together with a very little of the arsenical solution.

It is necessary, when dealing with iron and steel, to see that the articles are absolutely free from grease in any form, and they therefore should be washed in the potash solution, afterwards well rinsing out in clear water before suspending in the bath. The anode to be used in the black nickelling process is the same as would be used in ordinary white nickel-plating. It will be necessary every now and again to clean down the anode from the slime that will adhere. The arsenic is the main consideration in the blacking process, so that it is essential that the correct quantity is in the bath. If this is sufficient, then the colour of the deposit will be of an intense velvety black: while if the quantity is insufficient, then the tone will be somewhat lighter—in fact, of a grey shade. To make the solution correct, add the arsenic a little at a time, till the black is of the required depth. The finished articles may be buffed and finished in the same way as for white nickelling. They may afterwards have a coat of clear lacquer to protect the surface from abrasion.

Imitation Bower-Barff Finish.—A method of imparting a similar finish to iron and steel articles has been called an imitation Barff finish. It is accomplished by means of a carbon solution, so called because the anode consists of a carbon plate. The solution is made as follows: To 1 gal. of water add 1 lb. of iron sulphate, 1 lb. of sal-ammoniac, and 2 oz. of white arsenic. The white arsenic must be finely powdered, and may then be boiled at a gentle heat till solution is accomplished. The article to be treated should first be sand-blasted, to give a matt finish. Great care is needed, since the solution is apt to become thick and muddy. After depositing with the carbon anode, the articles are lacquered with a dead lacquer.

Saltpetre Bath.—Another and cheap method for blacking steel goods is by means of a saltpetre bath. The saltpetre is melted in an iron vessel, and, if kept a good heat, the articles readily turn black. They are dipped in the solution of nitre, and afterwards in paraffin oil to cool and prevent marking. If the heat of the solution is considerably reduced, then on placing the steel goods in the bath, the finish will assume an even blue tint. In each case the articles must be dipped in paraffin oil and wiped dry. The goods, previous to being dipped in the nitre bath, must first be polished, or may be barrelled, in order to obtain a smooth surface. The articles can then be lacquered or not, as desired.

Bluing. — The bluing of steel articles, especially if of a small or medium size, may be easily accomplished by using the following solution: Water 1 gal., hyposulphite of soda 2 oz., and acetate of lead 2 oz. After dissolving the soda and lead in the water, the whole is heated to boiling. If the richest finish is desired, the articles should have a dip of copper. The articles are dipped in the strong solution, afterwards being well rinsed and dried, and a coating of lacquer put on to protect the surface. Care must be taken that the article does not remain too long in the bath, or a grey or grey-black shade will appear.

CRYSTALLISED TIN

By means of this finish, the surface of tinplate is variegated with fine and coarse crystals. These crystals are produced by applying to the surface of the tin while in a heated state some dilute hydrochloric acid for a few seconds, afterwards washing with water, drying, and coating with lacquer. The figures are more or less diversified, according to the degree of heat used and the relative dilution of the acid.

A second method, which also gives good results, is as follows: Make a solution consisting of 4 parts of aquafortis to 2 parts of water in which has been dissolved 1 part of common salt or sal-ammoniac. The tinplate is warmed, and its surface well rubbed with the solution by means of a piece of sponge. As soon as the crystalline spangles are well brought out, swill the plate in water, dry at a low heat, and lacquer. If the surface is not immediately plunged in cold water, but is partially cooled by sprinkling cold water on it, the surface will be variegated by having large and small crystals mixed together.

LACQUERING TINPLATE GOODS

The colouring of tinplate is usually done by means of a celluloid dip, in which a colour has been intimately mixed. A number of colours, from blue to ruby through the greens, have been prepared by the Frederick Crane Chemical Company, and these have been largely used by manufacturers of tins such as are used by preserving and canning companies. Tins, such as meat tins, are coloured a deep blue shade by simple immersion in one of these tinted celluloid preparations. The tinted preparation is used in a deep jowl, and the various tins, after being dipped in the colouring dip, are placed to dry in a special stoving apparatus, usually heated by spent steam, which would otherwise be wasted. If any figuring or type is required on the tins, this is put on by the ordinary means of printing.

Fancy tinware, such as tobacco boxes, tins for cocoa, etc., are treated in a similar manner, the design being printed on, using preparations as first described. The advantage of this method of decoration is that the colouring solution can be thinned down by suitable means in such a way that only a thin layer is used.

Home-made Drilling Machines

Brace Arranged as a Drilling Machine.—Readers who possess a brace probably know the difficulty incurred in drilling a hole in metal. Even when a thin sheet is worked on, the time taken to complete the task is abnormally long. This is especially so if the metal happens to be iron or steel. Fig. 1 shows an appliance by means of which steel may be drilled without much labour. The writer has by this method bored a hole through a piece of 2-in. steel with less labour than he had previously drilled one through a piece $\frac{1}{10}$ in. thick.

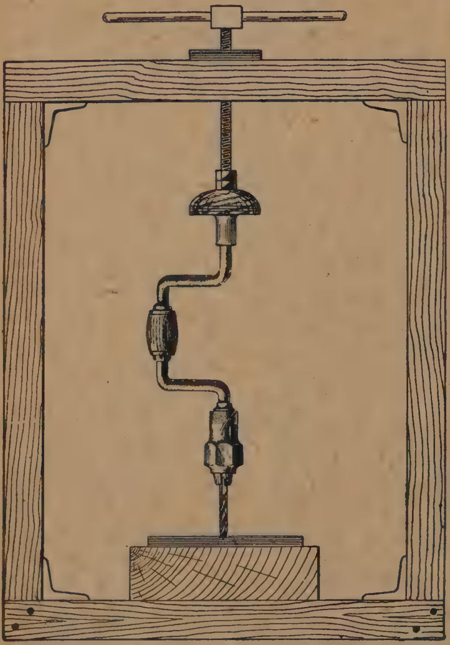


Fig. 1.—Brace Mounted for Use as Drilling Machine

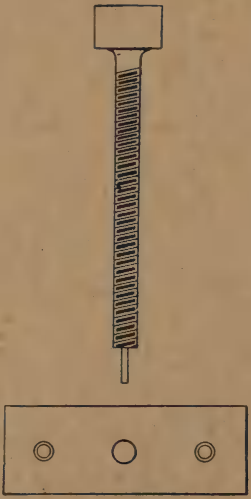


Fig. 3.—Bolt and Plate for Regulating Feed of Drill

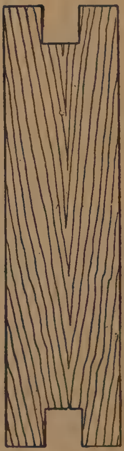


Fig. 2.—Wood Base for Drilling Machine

First procure a piece of wood 1 ft. 6 in. long by 6 in. wide and 2 in. thick for the base or stand of the apparatus. At each end cut out a piece 2 in. square, as shown in Fig. 2. Then fit two pieces of wood 2 in. square and about 2 ft. long in the ends, and fix with long nails, driven in from each side and also from the end, as shown in Fig. 1. Then cut another piece of square wood 1 ft. 6 in. long; lay this along the top of the two uprights, and fix with nails. Next strengthen the frame with angle irons, which can be fixed with ¾-in. screws at each corner, and it is ready for receiving the brace.

In the centre of the top piece drill a hole about ½ in. in diameter, and procure a bolt about 6 in. long, with a couple of nuts to fit, the bolt being about ⅜ in. in diameter. This may be purchased at any ironmonger's shop for a few pence. Then with a rough file make a shoulder at the end of the bolt, forming a kind of neck, which should be about ½ in. long and about $\frac{1}{10}$ in. thick (see Fig. 3).

Next procure a piece of iron about 3 in. long, 1½ in. wide, and ⅜ in. or ½ in. thick, and through the centre drill a $\frac{5}{16}$-in. hole. A ⅜-in. tap should then be put through the hole until the bolt is a good fit. At each end of the iron plate drill two ¼-in. holes and countersink them.

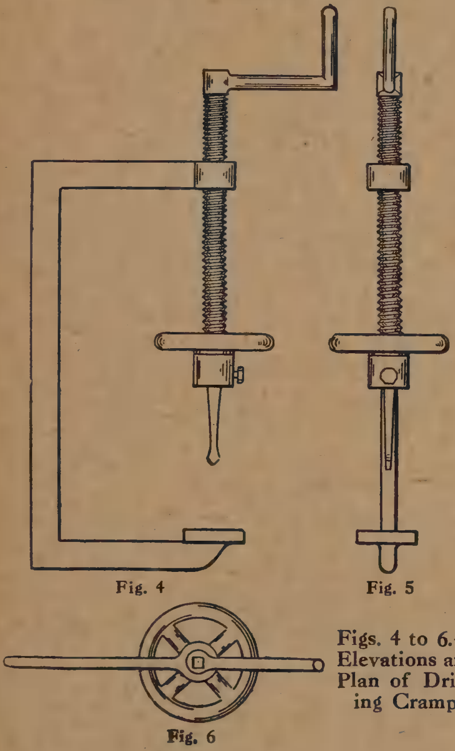


Fig. 4

Fig. 5

Fig. 6

Figs. 4 to 6.—Elevations and Plan of Drilling Cramp

To complete the drilling frame, fix the iron plate on the top of the frame with 1½-in. screws, taking care that the two central holes are opposite. Then screw in the bolt, and put on both the nuts, allowing the first one to come flush with the shoulder at the end of the bolt, and screwing the other one up against this from the back to lock it. A bar of iron with a square hole to fit the bolt head may now be fixed, and kept tight by means of a side bolt. The appliance is now complete, and may be painted.

To fix the brace, with a gimlet bore a hole in the centre of the head for the small spike of the bolt to enter. When not in use, the brace can instantly be detached. The pressure is regulated by means of turning the bar at the top.

Cramps for Drilling Holes.—The machine above described is actually little more than a cramp, and the same idea can be applied in a number of different ways. For example, the drilling cramp shown by Figs. 4 to 6 is especially suitable for drilling holes in work which, being fixed, it is impossible to take under a drilling machine, and is also suitable for work having a flat surface; while the cramp shown in Figs. 9 and 10 is adapted for work oval or circular in section, such as oval, half-round, or round bars, or iron pipes.

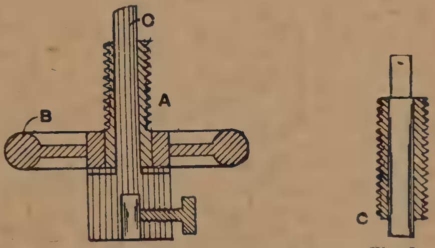


Fig. 7

Fig. 8

Figs. 7 and 8.—Details of Drilling Attachment

The drilling attachment shown by Fig. 4 consists of a jaw for the bit, on the end of which is a spill passing through a threaded pipe (see Figs. 7 and 8), which is screwed into the eye at the top of the cramp. The bit is fed by tightening the threaded pipe, and is turned by the handle fitted to the top of the spill.

The cramp is 1 ft. 3 in. long between the arms by 6 in. wide, and in section is $1\frac{1}{2}$ in. by $\frac{5}{8}$ in. The bearing at the bottom is $2\frac{1}{2}$ in. square by $\frac{1}{2}$ in. thick. The eye at the top is 2 in. in diameter, and is bored and screwed to take the threaded pipe A (Fig. 7), which is $1\frac{1}{8}$ in. in diameter. A cast-iron wheel B, 5 in. in diameter, is fixed to the end of the pipe, by means of which the latter is turned. The wheel may be fixed by screwing on to the pipe, and secured with a key or screw. The jaw for the bit is $1\frac{1}{2}$ in. deep by $1\frac{1}{2}$ in. in diameter; the spill C on the end of the jaw is $\frac{1}{2}$ in. in diameter, working through the pipe. The jaw is turned by means of the handle on the top end of the spill, the end of the spill being square in section to receive the handle. The handle is of $\frac{1}{2}$-in. round iron, and has a crank of 5 in.

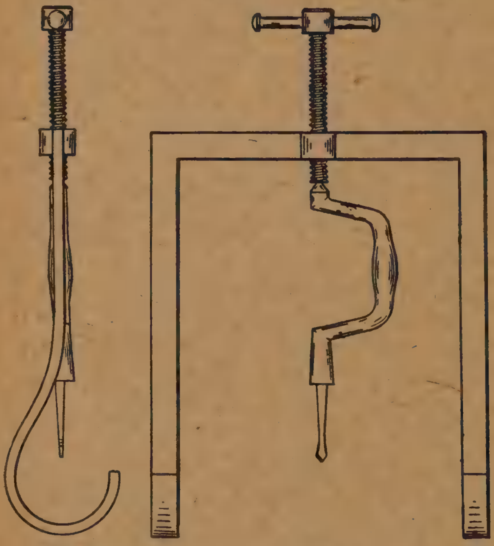


Fig. 9 Fig. 10

Figs. 9 and 10.—Drilling Cramp for Bars, Pipes, etc.

The drilling attachment shown in Figs. 9 and 10 is simpler than that shown at Fig. 4. It consists of an iron brace into which the bit is fixed, the bit being fed by a screw at the top. These drilling attachments are suitable for both of the cramps.

The cramp shown in Figs. 9 and 10 is 1 ft. 5 in. long by 1 ft. wide between the arms. In section, the cramp is $1\frac{1}{2}$ in. by $\frac{5}{8}$ in. A boss $1\frac{3}{4}$ in. in diameter is formed at the top in the centre, to receive the screw by means of which the bit is fed. The brace is $\frac{3}{4}$ in. in section, working in the screw as shown at Fig. 11, and is forged at the bottom end to take the bit.

Easily-made Sensitive Drilling Machine.— The great difficulty in drilling small holes is caused by the fact that the drill should revolve very quickly. When a small drill is running slowly, the amount of feed required is so very small that too much is apt to be given and so break it, because the feed is generally given by means of a screw or other mechanical appliance. In the machine shown by Figs. 12 to 14, half full-size with all the necessary details, the feed is applied by a touch of the hand or even of the finger, so avoiding excessive strain on the drill.

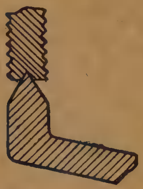


Fig. 11.—Detail at Top of Brace and Bottom of Screw

A sensitive drill is a great acquisition, it enabling the worker to use drills of high-speed steel, as well as to drill holes for sprays in oil and petrol engines and accessories. Some holes are as small as ·004 in. in diameter; a drill of this size requires about 2,000 revolutions per minute. The machine shown by Figs. 12 to 14 is only 5 in. high, with a base $\frac{3}{4}$ in. in diameter; and it can be made without castings, although these are very desirable for some parts.

To the base A is attached by means of two set-screws the upright piece B, and screwed on to this are the two slides C, between which the head D moves up and down. Carried in the head D is the circular portion E, which is fitted with two grooves for the driving band (this can be either a piece of string or leather), and which is hollowed out up the centre to carry the drill holder F; the latter is held in place by means of the small screw shown. The drill is held in the holder F by means of a nut G, which has a tapered thread inside. The top portion of the movable head D is fitted with a pointed screw H, on the centre of which the pulley piece runs as shown in Fig. 12.

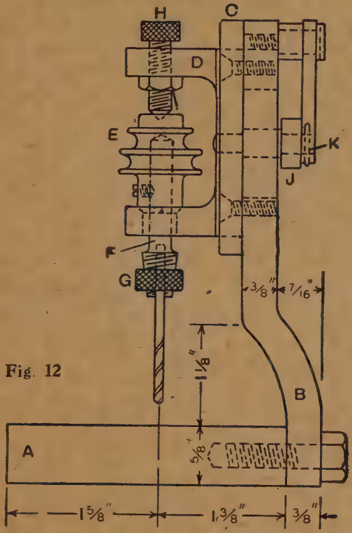


Fig. 12

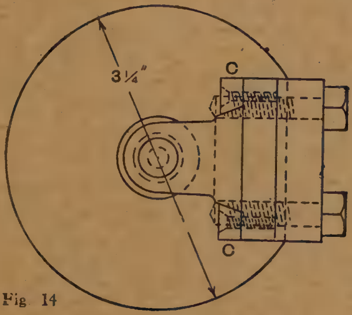


Fig. 14

When the drill is used, the lever J (see also Fig. 13) is pressed down by the hand, and as the lever is attached to the sliding head by means of the pin K, it follows that the head will move up and down with the lever. Any binding on the part of the drill will be felt by the hand when it is resting on the lever, thus making the drill extremely sensitive. The drill may be driven by means of string passing over the treadle wheel of a sewing machine, and then over two small vertical pulleys, which are fitted in the most convenient position. If the machine can be fitted in the same horizontal plane as the centre of the wheel from which the drive is taken, no vertical idle pulleys will be necessary.

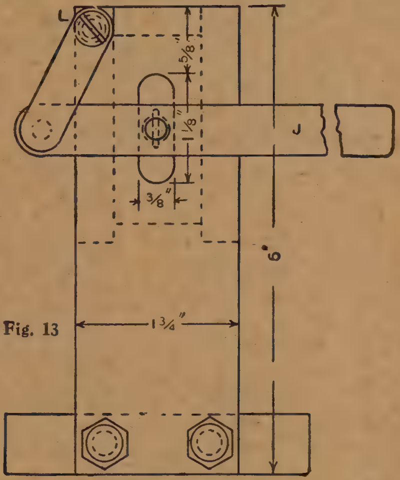


Fig. 13

Figs. 12 to 14.—Elevations and Plan of Sensitive Drilling Machine

The base A may be made from cast-iron, and in this case a pattern will be required; but no machining is necessary for the circular shape and the flat on which the upright B is fastened. If the base is made from mild steel it will be necessary to roughly machine or file the outline. The upright B can be made of mild steel, and bent to the shape shown; or a pattern can be made and the shape obtained in the casting. This part must be machined or carefully filed, both where it fits on to the base and where the head and slides fit. A slot is also cut in it as shown in Fig. 13, in order to allow the pin K to move up and down while the machine is in use.

The head D is shown in detail by Figs. 15 to 17. It is the more convenient to make a pattern for this part, as the shape is then obtained very easily. It is possible to make it from a mild steel forging, but considerable machining would be necessary. The parts that require machining are the three holes shown (and dimensioned) and the back, along with the two bevelled sides that fit between the slides. It will be seen that the large hole in the bottom flange of the head is bevelled; this is to assist in centralising the drill holder, as in case the lower portion of the pulley or the hole in the head wears, the bevel will still assist in keeping the pulley central.

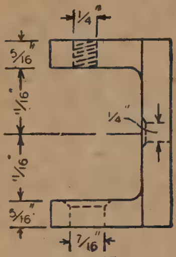


Fig. 15

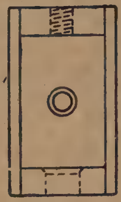


Fig. 16

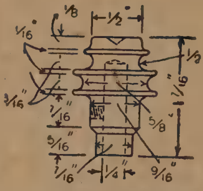
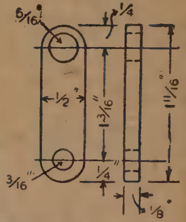


Fig. 18.—Pulley



Figs. 19 and 20.—Connecting Link

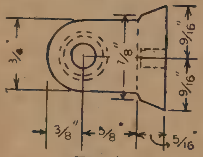


Fig. 17

Figs. 15 to 17.—The Drilling Head

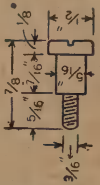


Fig. 21.—Pin for Hand Lever

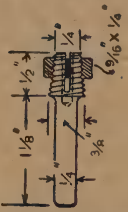


Fig. 24.—Drill Holder

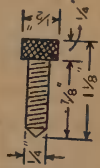


Fig. 27.—Centre Screw

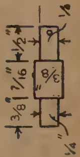
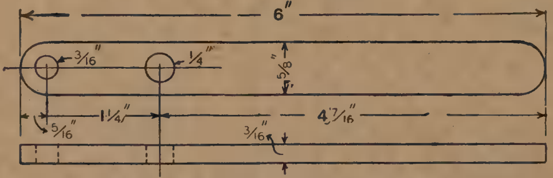
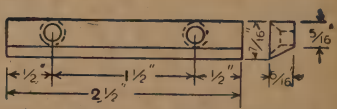


Fig. 28.—Pin for Moving Head



Figs. 22 and 23.—Hand-feed Lever



Figs. 25 and 26.—Slides

The pulley (Fig. 18) should be turned out of a bar of mild steel 1 in. in diameter, and then the long hole carefully bored. It should be bored roughly, and reamed out in order to give a smooth finish. A small screw is fitted in the side, between the largest pulley and the bevelled portion that fits into the head. The top portion in which the centre is drilled should be case-hardened in order to prevent wear of the centre, and consequently the drill running out of truth.

The link (Figs. 19 and 20) should be made out of mild steel, and requires little machining except for the two holes; the $\frac{5}{16}$-in. hole fits over the pin (Fig. 21), which is screwed into the upright B (Fig. 12), and the $\frac{3}{16}$-in. hole is for a rivet, which loosely secures it to the long lever (Figs. 22 and 23). The pin (Fig. 21) is made from a piece of mild steel bar $\frac{1}{2}$ in. in diameter, and is screwed into the upright piece of the machine as shown at Fig. 13.

The feed lever (Figs. 22 and 23) can be made from a piece of mild-steel bar, and no machining is required, except the drilling of one $\frac{1}{4}$-in. and one $\frac{3}{16}$-in. hole.

The drill holder and nut (Fig. 24) may be made out of mild steel, but cast-steel would be better. It is screwed taper, and a small hole (according to the size of the drill shank) is drilled up. Three fine saw-cuts are made from the outside of the screwed portion to the centre holes, thus permitting the holder to close tightly on the drill when the nut is screwed up. This nut should be knurled or milled on the outside, to facilitate it being tightly gripped with the fingers. The slides (Figs. 25 and 26) can be made from mild steel carefully filed up, two holes being drilled for countersunk screws, by means of which the pieces are held on the upright piece B (Fig. 12).

The pointed screw (Fig. 27) should be made from cast-steel, and the pointed end hardened to prevent wear. This screw is adjusted from time to time, the lock nut shown in Fig. 12 being provided in order to keep it from working loose.

The pin (Fig. 28) is made from a piece of mild-steel bar $\frac{3}{8}$ in. in diameter; it is tightly driven in the $\frac{1}{4}$-in. hole in the movable head, and then riveted over. The portion that is $\frac{1}{4}$ in. in diameter fits loosely in the hole in the long lever, and a small pin can be put through behind the lever in order to prevent it coming off.

This, with the exception of a small washer which is placed on the pin (Fig. 21) to hold the link (Fig. 20) in correct position, completes the machine, which will be found to give wholly satisfactory results.

Galvanising

By galvanising is meant merely the application of a coat of zinc which alloys with the surface of the metal to which it is applied. Thus the material known as "galvanised iron" is sheet-steel (which has superseded iron) upon which has been deposited a film of zinc. The success of the following process depends on the thoroughness with which the metal is cleansed previous to being passed through the molten zinc.

The work is first immersed in a warm bath of equal parts of sulphuric or muriatic acid and water, being afterwards scoured with emery or sand. It is now ready for the preparing bath, made by mixing together equal parts of saturated solutions of chloride of zinc and chloride of ammonium.

The metallic bath through which the work is next passed is a molten alloy of 640 parts (by weight) of zinc, 106 parts of mercury, and $\frac{1}{4}$ part of sodium. Throw some sal-ammoniac on the top of the bath, previously skimming off any oxide that might have formed, and immerse the articles, bringing the temperature up to 680° F. Remove the articles directly this heat is attained, otherwise the zinc will dissolve a portion of the iron. Zinc has a great affinity for iron, and it is a good plan to partly satisfy this by allowing the molten zinc to previously act on a piece of waste wrought-iron.

Small articles of solid iron or steel are galvanised preferably by the following method: The articles are cleansed in a revolving barrel or tumbling box containing sand, which chafes the iron and removes scale, etc. A solution is made by saturating with sheet-zinc 10 parts of hydrochloric acid, and, when the evolution of gas has ceased, dissolving in it 1 part of muriate or sulphate of ammonia. The iron articles are heated and plunged in this solution for an instant; if of the right heat, they will dry at once on removal and be covered with crystals. Prepare a bath of molten zinc as before, removing all oxide and throwing in plenty of sal-ammoniac to stop further oxidation. Heat the articles, dip them whilst quite dry into the zinc, shake off superfluous metal, and cool in water. Small articles may be held in a wrought-iron basket when dipping into the zinc.

Repairing Leaky Roofs

The defects most generally met with in leaky roofs are cracked fillets, caused by vibration; insufficient lap of the roof covering (the lap should increase as the pitch of the roof decreases); irregularity of bond; hollowness of the roof owing to the weakness of the roof timbers; holes in the gutters (generally at the place where they are soldered, or at the angles); and choked gutters and broken slates.

When a roof is to be repaired, the leaks should be located by measurements taken inside the house, using one of the walls or a window as a guide. If this does not discover the source of the leak, a few slates must be taken off and the search renewed. Another plan is to allow water to trickle down the outside of the roof directly over the suspected place; by removing a few slates where the water has drained off, the weak spot will be plainly seen. It is generally at the angles that fractures occur, and nothing is so effectual a preventive as flashings all up the wall, or lead soakers. If soakers are used, they should be secured to the wall or to battens in order to prevent them from slipping down.

As a rule, the ordinary fillet cannot be depended on to keep out water; it is badly shaped, being triangular instead of rectangular, and clings to the wall rather than to the roof, the former being rougher and more rigid than the latter. When a fracture occurs (fractures being caused by the vibration to which every roof is subject, and by extremes of temperature), it is always the roof that separates from the fillet, and an opening for the admission of water is formed.

Sometimes, especially during storms, water will penetrate a roof though the slates are perfectly sound; this is the result of insufficient lap. If the roof is otherwise in good condition, it will be sufficient to strip a portion about 3 ft. square just over the spot where the water enters, and give an extra lap to the slates or tiles when replacing them. If it is thought that such partial stripping of the roof will spoil its appearance, a piece of zinc, wide enough to cover the joint or joints where the water finds an inlet, may be inserted between the slates, the zinc being pushed upwards as far as the nails will allow; of course, the zinc must not come down below the bottom edge of the slate so as to be seen. The amount of lap to be given must depend on the pitch of the roof, the nature of the roof covering, and the local peculiarities of the climate. Should the amount of lap vary in the same roof, the largest lap should be given at the bottom, and the least at the top. The bond of the slates can only be kept properly by starting correctly. Slates should be trimmed to a uniform size, and the half-slate on the second course, to break the joint, should be exactly half the width of a whole slate. The practice of using small strips of slate for the under-eaves, just breaking the joint by about 2 in., and leaving an open space, cannot be too greatly condemned, for it is at this point that the greatest volume of water collects. Such a leak does not often show itself on the ceiling, but soaks into the wall, on which, eventually, it makes its presence known by ugly dark patches. The slates at the under-eaves should fit as closely as at any other part of the roof.

To ascertain the position of a leak on a flat or in a gutter, careful measurements must first be taken inside the rooms, and the gutter must be cleared and washed out and wiped dry. A hole or a crack in a zinc gutter shows as a dark line on the surface of the zinc. Fractures in lead are generally not so easily discovered, but they can be found by wiping the surface with a dry rag and watching carefully for the appearance of any damp spots caused by water oozing from the crack. Soldering should be avoided as much as possible. For leaks caused by broken slates and stopped-up gutters the remedy is obvious.

Finally, it should be remembered that when a leak shows itself on a ceiling the rain does not always enter the roof just above it; very often the water travels some distance along the roof timbers before it finally drops on to the ceiling.

Testing Metals by Touchstone

THE art of assaying, in its entirety, can only be carried out in a well-appointed laboratory by men who have had practical training; but the approximate quality of alloys containing gold, silver, and other precious metals may be easily determined by the every-day worker aided by simple, inexpensive apparatus.

The most simple and also the most ancient method of roughly indicating the quality of gold and silver alloys is that in which the touchstone is used. It is a colour test by comparison, and therefore can only be of use to those who are able to compare delicate shades of colour. The requisite apparatus is merely a piece of black stone, and a collection of specimen alloys for comparison. The stone usually employed is a species of black porphyry, but black marble or slate may be used, or any dark stone, such as those in use as oil-stones. The size is immaterial, but a strip 4 in. by 2 in. by ½ in. will be found convenient. Specimen pieces of the alloys in general use are usually kept in the form of needles, or 2-in. lengths of wire in gauges of 22 to 16; but any other form will do equally well; pieces of thick foil, or even chips of metal, will answer. It is advisable to know the quality of each such sample, and to keep the whole in a case, such as a needle case, divided into compartments numbered or lettered and furnished with a reference table describing the quality of each number or letter. Two 2-oz. glass-stoppered bottles containing dilute acid will be required. One of these should contain a mixture of nitric acid, 78½ parts; hydrochloric acid, 1½ parts; and water, 20 parts; and the other should contain sulphuric acid, 25 parts; and water, 75 parts.

Testing Gold and Brass.—To use the touchstone method of detecting the quality of an alloy, first rub the stone with one corner or side of the specimen until a well defined narrow metallic streak is shown. If the alloy is one of gold or of brass, this streak will be some shade of yellow. An experienced eye will be able to guess the quality of this streak closely enough to select a needle corresponding with it. This needle is rubbed on the stone side by side with the first streak, and the colour of the two streaks noted. If they are alike in tone of colour, they are probably alike in quality. If brass is suspected in the tested streak, apply a touch of the dilute sulphuric acid on the tip of a glass rod to the streak. Should it be brass, the yellow tint will promptly disappear, because this alloy is soluble in the acid; but gold is not soluble, so the colour will remain. If still there is a doubt, apply the dilute nitric acid and note results. The yellow tint should still remain if there is gold in the streak. If gold is heavily alloyed with copper, the streak will have a reddish tint resembling the colour of bronze, and the streak given by 9-carat gold may be easily mistaken for that of bronze; but a touch of dilute nitric acid will soon dissolve the copper and reveal the yellow tint of gold. If the gold is alloyed with silver, the streak will be of a pale yellow tint and may slightly resemble that of silver heavily alloyed with copper; but here again dilute nitric acid will reveal the gold.

Testing Silver Alloys, White Metal, etc. — Silver alloys are distinguished in a similar manner. A streak of pure silver will be of the well-known silvery white. Aluminium will give a bluish streak, which may be dissolved with a touch of caustic alkali. Nickel and cobalt and iron will leave steely white streaks readily altered with a touch of hydrochloric acid. Zinc will also leave a bluish white streak also soluble in hydrochloric acid. A very little practice will soon educate the eye to discern the difference between the colour of these streaks and those of a silver alloy. Some of the heavier silver alloys below the standard quality may easily be confused with the streaks of german silver and some of the imitation silver alloys imported from the Continent under the name of white metal; but these may be distinguished from silver by moistening the streaks with dilute sulphuric acid. This acid will slowly dissolve german silver and similar white alloys containing copper and zinc, but will have little or no effect on the silver streaks. By comparing the colour of these with those of the test needles, the quality of the alloy may be found.

Testing Plated Articles, etc.—When brass has been thickly coated with gold, as in rolled gold articles, it is somewhat difficult to detect the quality by the touchstone, and a trained eye is necessary to tell the difference between a streak of real and rolled gold. But here a touch of dilute nitric acid will reveal the brass by the green tint given to the acid. A similar difficulty occurs when white metal is thickly coated with silver, and it needs an expert eye to detect the difference between the mark of this and of standard silver, even with the aid of acid. If the silver plating is on brass, the streak will be yellowish, and if on copper it will be pink.

Cleaning the Stone.—Streaks made on the stone may be removed by covering them with a little dilute nitric acid and then rinsing in clean water, finally drying by rubbing with a clean rag. It is advisable to keep the whole apparatus in a neat case, such as a shallow box with a hinged cover.

Qualities of Gold.—As is, of course, well known, gold is too soft and too expensive to use fine, that is, absolutely pure, so it is alloyed with silver and copper. For the purpose of estimation, the mass of gold alloy is divided into twenty-four imaginary equal parts, termed "carats," and the alloy is known by the number of carats of fine gold that it contains. The term "carat" applied to gold does not, in the United Kingdom, refer to the weight; it indicates only the relative purity, although it formerly was a unit in the now obsolete system known as "refiner's weight," 24 carats then being equal to 12 oz. At the present time, a carat weight is not used by gold- and silver-smiths, but diamond dealers use it, and it then has a fixed value of four grains troy, or five diamond grains.

Fine gold is 24 carat, that is, every one of its imaginary twenty-four parts is of pure gold; 22-carat gold contains twenty-two twenty-fourths of fine gold and two twenty-fourths of base metal; 18-carat gold contains eighteen parts of fine gold and six parts of base metal; and so on, Most of the standards of gold are purely arbitrary, those in use in Great Britain numbering six: 22 carat, 18 carat, 15 carat, 12 carat, 9 carat, and, in Dublin only, 20 carat.

At the authorised assay offices, of which there are about nine in the United Kingdom, gold and silver for assaying and hall-marking are accepted only from those makers who have registered the design of their name-punch at the assay office.

Among the "hall marks" on gold and silver is one that is known as the "quality mark."

The quality mark denotes the number of carats (twenty-fourths) of fine gold contained; this mark always is a figure, 22 (for 22-carat gold), 18 (for 18-carat gold), 15, 12, and 9. In the case of the lower three, decimal fractions also (·625, ·5, and ·375) are given in England and Ireland, but not in Scotland; these fractions show the proportion of fine gold in 15-carat, 12-carat, and 9-carat gold respectively. Another of the "hall marks" is the "standard" mark, this also denoting the quality. In England, 22-carat and 18-carat gold have a "crown" stamped on them; there are no "standard" marks on poorer alloys than these in England, Ireland, or in Edinburgh; in the last place 22-carat and 18-carat gold is marked with a "thistle"; while a "lion rampant" in conjunction with figures is the mark for all five standards in Glasgow. In Ireland the "harp crowned" denotes 22-carat gold, the "plume of three feathers" 20 carat, and a "unicorn's head" 18 carat.

The value of gold is constant, being determined by the face value of the coins that could be made from it. A thousand parts of gold coin alloy (British gold coin alloy is always 22 carat) contains 916·6 parts of gold, the rest being copper; and if an ounce of gold were alloyed with 1 dwt. 19 gr. of baser metal (to conform to the above proportion) and then struck into coins, the value of these coins would be exactly £4 4s. 11½d.; this, then, is the value of one ounce of fine gold. An ounce of coin gold contains, of course, less than 1 oz. of fine gold.

Qualities of Silver.—There are two legal standards for silver: one, the older, containing 18 parts of copper and 222 parts of silver, and the new one containing only 10 parts of copper and 230 parts of silver. The old standard is "sterling silver" whilst the new standard—not much used—is "new sterling" or "Britannia silver." Thus, whilst gold has five or more recognised standards, silver has only two—practically only one. English silver currency conforms to the old standard—that is, in every 12 oz. troy there is 11 oz. 2 dwt. of fine silver the proportion being 92·5 per cent. silver and 7·5 per cent. alloy. Old standard silver is "hall marked" in England with a "lion passant"; in Edinburgh by a "thistle"; in Glasgow by a "lion rampant," and in Dublin by a "harp crowned." The new standard silver is marked by the figure of "Britannia" in England (London having in addition the "lion's head erased"), by the "thistle and Britannia" in Edinburgh, and by the "lion rampant and Britannia" in Glasgow; it is not marked in Ireland, and right throughout the United Kingdom it is but little used owing to its softness; it was a compulsory standard for only a short time.

Thatching a Roof

THE thatching of a roof consists of layers of straw (wheaten straw lasts twice as long as oaten) about 15 in. thick, tied down to laths with withes of straw or with string. Thatch is an excellent non-conductor of heat, and consequently buildings thus roofed are both cooler in summer and warmer in winter than others; no better roof covering for a dairy can be found. Thatch is, however, highly combustible, and as it harbours vermin and is soon damaged, it is not really an economical material, though the first cost is small.

A load of straw will do 1½ "squares" of roofing, or 150 ft. superficial (a square is 100 sq. ft. or superficial feet). First-class thatching is an art not readily acquired; while really good thatching will stand for twenty years, average work will not endure ten years.

The operation may be briefly described as follows: For renewing an old thatch the best and cheapest material is "stubble" (the lower and stiffer half of wheaten straw); but for new thatch, stubble alone is not long enough, and must be used with straw, or be replaced entirely by straw. The material is thoroughly soaked with water, and then straightened out with the hands, so as to arrange the straws all in one direction, termed "drawing." When a double handful (called a "yelvin") has been thus prepared, it is laid aside until a sufficient number are ready to fill a "jack" (large forked stick), in which they are placed just so much out of parallel as to be easily separated. A small hook in the jack permits it to be hung from the thatcher's ladder. A thatcher's fork is shown in Fig. 4.

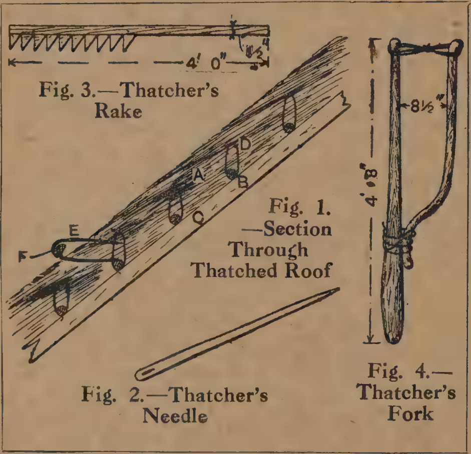


Fig. 3.—Thatcher's Rake

Fig. 1.—Section Through Thatched Roof

Fig. 2.—Thatcher's Needle

Fig. 4.—Thatcher's Fork

Beginning at the eaves and working upwards to the ridge, proceed to lay a strip of thatch on the opposite side of the ladder from that carrying the jack. The strip laid (technically a "stelch") is of convenient width for the workman's reach; it will be of equal breadth throughout if the section of roof is square, or taper gradually upwards if the area is triangular. The thatcher begins by forming the eaves at the bottom of the stelch, and fastens this portion securely before proceeding to the next yelvin.

The mode of fastening varies, and, indeed, the details of thatching, the materials, and the terms used, vary considerably in different districts. In renewing old thatch, the new material is secured by thrusting the upper ends into the old thatch with a wooden span. In new thatching, the straw or thatch A (Fig. 1) is bound to the rafters C and laths B with tar cording D passed, by means of a huge needle (Fig. 2), through the straw near the upper end of the yelvin, where it will be covered by the next instalment. Each succeeding addition, as the work advances towards the ridge, is made to overlay the preceding one, except the lower end, and is secured by the tar cording.

When the whole stelch is finished from the eaves to the ridge, the thatch is combed straight with a short-toothed wooden rake (Fig. 3). Every succeeding stelch must be so united to its predecessor that no gap or weak part is left to mark their junction, otherwise it will not be watertight. The security of the thatch is further ensued by furnishing it with a series of buckles E and runners F on the outside. Buckles are a kind of huge wooden hairpin, made by splitting withes, shaving the middle somewhat thinner than the remainder, twisting it two or three times, bending it end to end, cutting it to a length of 12 in. to 18 in., and pointing the ends. Runners are simply long strips of split withes laid in horizontal bands on the thatch, and held by the buckles, which are thrust upwards into the thatch. The buckles are placed 6 in. to 12 in. apart, and two series of buckles and runners are generally adopted, an upper series just below the ridge, and a lower series just above the eaves with additional series wherever there is exposure to strong winds. The eaves are trimmed off evenly with shears.

The best method of finishing off at the ridge is by a kind of plaiting of the straw, not easily described. A simpler substitute is to plaster with road dirt, and plant a weed such as houseleek or stonecrop in the soil.

Gauges for Wire and Sheet-metal

A GREAT many different sizes of wire and thicknesses of sheet steel are manufactured, and it is the custom to distinguish them one from another by means of numbers instead of by the dimensions of their diameters or thicknesses. There is no one gauge or system of numbers universally employed. Indeed, it is on record that in 1879 fifty-five different gauges were in existence, no less than forty-five of these being used in the United Kingdom. Many of these are now obsolete, but a number is still in use, with the result that there exists a great amount of confusion that could easily have been avoided. One gauge would probably be quite enough at the present time in Great Britain, and that one the British Imperial Standard, although it must be admitted that many people consider the Whitworth gauge to be a more sensible one. Comparative tables of fourteen of the best-known gauges are given on p. 327.

Sir Joseph Whitworth's gauge was introduced in 1857; it ranges from ·5 in. (No. 500) to ·001 in. (No. 1) by regular gradations of ·001 in., and has the advantage that the number of the gauge is a key to the dimension; whereas, in the gauges chiefly in use, the number does not suggest the dimension, and there is no apparent association, for instance, between 1 B.W.G. and its corresponding dimension ·3 in. In most gauges, the lowest number denotes the thickest wire; in Whitworth's the reverse is the case.

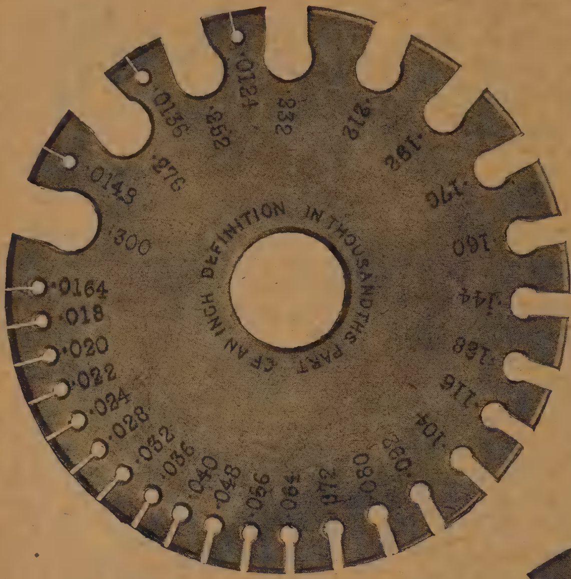
The British Imperial Standard gauge (S.W.G.) is often called the Standard, British Standard, the Imperial Standard, and the English Legal Standard. It was authorised by Act of Parliament on September 4th, 1883, and it came into use on March 1st, 1884. Its gradations extend from 7/0 = ·5 in. to 36 = ·0076 in., there being forty-three numbers.

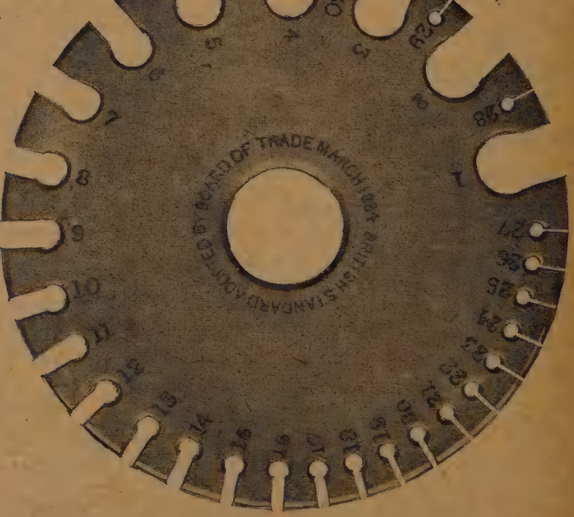
The Birmingham Wire Gauge (B.W.G.) has long been a favourite in England. It is the same as the London or Old English gauge, from numbers 0000 4/0 to 18; from 19 to 36 there are slight differences in the second or third decimal point. It agrees with the ordinary Stubs gauge for iron, but not with the special Stubs gauge for steel wire.

The American (Brown and Sharpe) wire gauge (B. & S.W.G.) is, of course, but little used in Great Britain, although it is the gauge used almost exclusively in the United States for the measurement of sheet brass, aluminium, and german silver and for brass and german silver wire. Brown and Sharpe, dissatisfied with the imperfect gauges previously in use, devised this special gauge in which the divisions increase by a regular geometrical progression.

The United States Gauge, legalised in 1893, applies to sheet and plate iron and steel.

In the S.W.G., B.W.G., B. & S.W.G., etc., the thicker wires (those greater than 0·3 in. in diameter) are designated by a number of ciphers, not exceeding seven or eight. These are sometimes given in full, as, for example, 000000, but more generally the number of ciphers is denoted by a numeral, as, in the example given, 6/0.





Figs. 1 and 2.—Two Sides of Standard Wire Gauge

Letters instead of numbers are used on the Lancashire steel wire gauge (not to be confused with the Lancashire pinion wire gauge).

Strong objections, as already suggested, have been urged against the system of denoting various sized wires by gauge numbers instead of by the actual dimensions. The chief objection is the liability to mistake, there being so many different gauge systems in use; also manufacturers have to make and stock many sizes which are slightly different. There is no doubt that it would be a more sensible plan to designate the size of a wire by its diameter, thus "diam. 0·5" instead of "S.W.G. 0000000." The former term gives precise information to anybody, whereas the latter does not mean anything to a person unacquainted with the gauge system. This has been recognised by Messrs. Pratt and Whitney, of Hartford, Conn., U.S.A., an American firm whose products can readily be bought in England; they make a specialty of the decimal gauge, a notched oval plate gauge patented in June, 1896, and manufactured under licence of the American Society of Mechanical Engineers. This gauge has been adopted as the standard of the American Railway Master Mechanics' Association. In it the sensible system is followed of designating each size of wire by its thickness in decimals of an inch. In the Standard wire gauge illustrated by Figs. 1 and 2, one side bears the gauge numbers and the other the corresponding dimensions in decimals of an inch. These two illustrations show the gauge as accurately to the actual size as ordinary bookwork printing from half-tone blocks allows. The sizes of the larger notches are sufficiently exact to render possible the measurements of wires and sheet-metal simply by placing these on end down on the illustrations. The gauge from which these figures were photographically prepared costs from seven to ten shillings.

The actual gauge or measuring tool may be in one of three types and many different patterns. The types include the notched gauge, hole gauge, and angular slotted gauge.

The notched gauge has a series of notches, in which the wire is successively tried until one is found which it exactly fits. Then the number stamped close to the notch is the "gauge" of the wire. The ordinary disc gauge (known as "circular single") is shown by Figs. 1 and 2; and of its type it is probably the best. The method of using it is shown by Fig. 3. The double gauges (Fig. 4) are either circular or oval, and are a convenient form for the pocket. The oblong gauge (Fig. 5) is obtainable pocket size; a folding pattern of it (Fig. 6) will appeal to many workers. Brown and Sharpe (the well-known firm of Providence, R.I., U.S.A., whose tools can always be obtained without difficulty in England) make a combined gauge and calliper shown by Fig. 7, this being a handy tool when selecting metal plates for special purposes.

The hole gauge (Fig. 8) is used for pinion wire, drills, taps, etc. The wire is tried successively in likely holes until one is found that it fits, just as the notched gauge is used. The adjacent number indicates the gauge of the wire. The gauge has a special use in connection with drills. Gauges of this kind are obtainable to correspond with any system.

The simplest of all gauges and the most scientific is the angular slotted type, the pocket form being generally made with closed ends as in Fig. 9, while the jeweller's gauge has an open end to the angular slot. Fig. 9 shows the Brown and Sharpe pocket wire and screw gauge, which, together with all gauges of this type, is used by passing the wire into the angular opening until it touches on both sides and cannot go farther; the number stamped on the right of the slot at the point of contact indicates the gauge of the wire according to the American Standard screw gauge. The back of the gauge is graduated B.W.G. on the right side, and B. & S.W.G. on the left side. The gauge shown by Fig. 10 is made to meet the special requirements of jewellers. The gradations are on the Whitworth system from 1 to 250, 1 indicating ·001 in., and 250 indicating ·250 in.

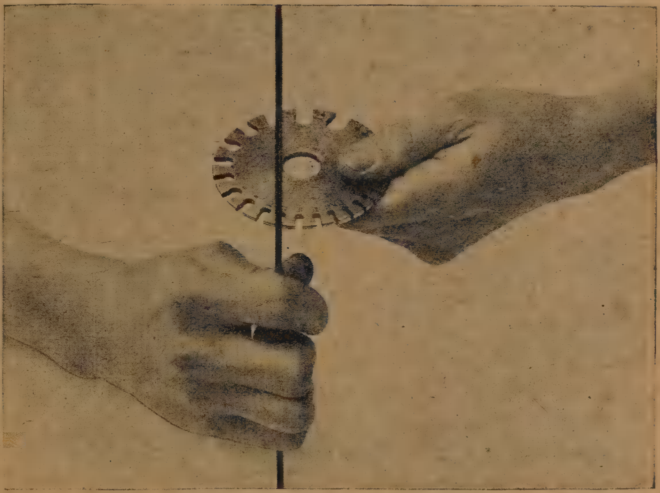


Fig. 3.—Using the Wire Gauge

Poole's patent gauge has a crescent-shaped slot, an angular slot bounded by two circular arcs. It is for the especial use of electricians, as not only does it denote the S.W.G. of the copper wire tested, but it shows the diameter in mils. (1,000 mils. = 1 in.), and in millimetres (1 mm. = ·03937 in.), the sectional area in thousandths of a square inch, the safe current carried, the electrical resistance, the length in yards per legal ohm, resistance at 60° F., and the weight per 1,000 ft. This wire gauge is about 1½ in. in diameter.

The prices of wire gauges may appear at first sight extremely high, and out of all proportion to the cost of production. An

English-made British Standard gauge of the single-circular form, best finish, costs from 6s. to 11s.; an oblong gauge costs from 6s. to 8s. A B & S. angular slotted gauge costs about 10s., and a jeweller's gauge of this pattern about £1. But precision work of this kind is extremely expensive; everything must be sacrificed to accuracy, which, of course, means time and money, Each gauge is carefully hardened after the slots have been roughly cut out. After tempering, the faces of the slots are ground, or lapped, in special and accurate machines. The gauges are fixed in a machine in the rough state and slotted out with milling cutters; it is only the finishing that is expensive. If a slot is made too large, the gauge has to be thrown away, and, if the inaccurate slot is the last one to be finished, it will be easy to understand the time and money wasted. It frequently happens that some of the gauges crack in hardening; this, of course, involves another loss.

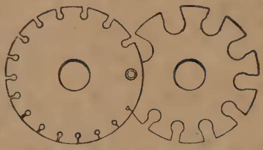


Fig. 4.—Double Disc Gauge

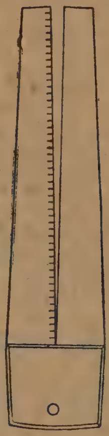


Fig. 10.—Jeweller's Angular Gauge

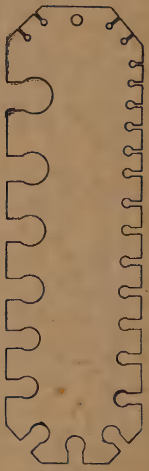


Fig. 5.—Oblong Gauge

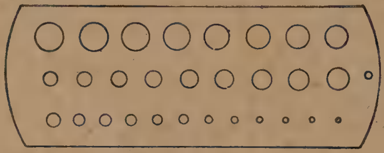


Fig. 8.—Drill Gauge

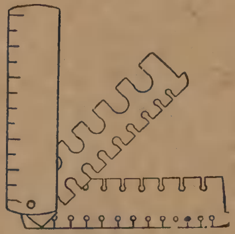


Fig. 6.—Folding Gauge

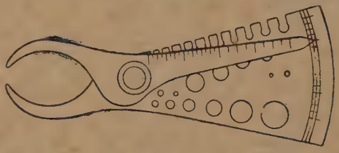


Fig. 7.—Combined Gauge and Calliper

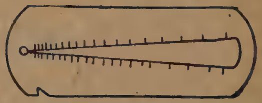


Fig. 9.—Pocket Angular Slotted Gauge

A recording gauge (Figs. 11 and 12) can easily be made from $\frac{3}{32}$-in. sheet steel, a piece cut from a broken saw, after softening, being very suitable. The body of the instrument, shown by Figs. 13 and 14, can be marked out from the illustrations, which are full size. The outside should be roughly chipped to size, and then finished by drawing a smooth file along, and not across, the edges. After filing, worn-out emery-cloth should be used for polishing. Two tacks can be driven through the two holes A and B (Fig. 13) into a piece of wood held in the vice. The surfaces can then be draw-filed, and polished with worn-out emery-cloth and oil; the emery-cloth should be wrapped round a piece of flat wood. After polishing the leg must be bent as shown in Fig. 14,

GAUGES FOR WIRE AND SHEET-METAL: COMPARATIVE TABLES

Number of Gauge.	British Imperial Standard or English Legal Standard.		American or Brown and Sharpe.		Birmingham or Stubs Iron.		Gold and Silver (Birmingham).		Lancashire Steel Pinion Wire.		Lancashire Steel Wire Letter Gauge.		London or Old English.		Morse Steel Wire Gauge for Drills.		Music Wire Gauge, English.		Music Wire Gauge, Washburn and Moen.		Sheet and Hoop Iron.		United States Standard for Iron and Steel Plates.		Warrington.		Whitworth.		Number of Gauge.
	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	
7/0	·500	12·70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	·008	·203	—	—	·500	12·70	·500	12·70	—	—	**7/0**
6/0	·464	11·78	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	·009	·228	—	—	·469	11·908	·468	11·88	—	—	**6/0**
5/0	·432	10 97	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	·010	·254	—	—	·438	11·123	·4375	11·11	—	—	**5/0**
4/0	·400	10·16	·46	11·68	·454	11·53	—	—	—	—	—	—	·454	11·53	—	—	—	—	·011	·279	—	—	·406	10·31	·406	10·31	—	—	**4/0**
3/0	·372	9·44	·409	10·388	·425	10 787	—	—	—	—	—	—	·425	10·787	—	—	—	—	·012	·304	·500	12·70	·375	9·517	·375	9·517	—	—	**3/0**
2/0	·348	8·83	·364	9·24	·380	9·65	—	—	—	—	—	—	·380	9·65	—	—	—	—	·013	·330	·445	11·297	·344	8·731	·344	8·731	—	—	**2/0**
1/0	·324	8·23	·324	8·23	·340	8·63	—	—	—	—	—	—	·340	8·63	—	—	—	—	·014	·355	·406	10·312	·313	7·946	·326	8·27	—	—	**1/0**
1	·300	7·62	·289	7·338	·300	7·62	·004	·101	·227	5·757	Z ·413	10·48	·300	7·62	·228	5·783	·011	·279	·015	·381	·353	8·966	·281	7·135	·300	7·62	·001	·025	**1**
2	·276	7·06	·257	6·527	·284	7·21	005	·127	·219	5·558	Y ·404	10·26	·284	7·21	·221	5·605	·012	·304	·016	·406	·314	7·971	·261	6·625	·274	6·95	·002	·050	**2**
3	·252	6·40	·229	5·808	·259	6·578	·008	·203	·212	5·380	X ·397	10·07	·259	6·578	·213	5·406	·013	·330	·017	·431	·280	7·11	·250	6·35	·250	6·35	·003	·076	**3**
4	·232	5·89	·204	5·18	·238	6·04	·010	·254	·207	5·257	W ·386	9·80	·238	6·04	·209	5·308	·014	·355	·018	·457	·250	6·35	·234	5·94	·229	5·808	·004	·101	**4**
5	·212	5·38	·181	4·59	·220	5·58	·013	·330	·204	5·181	V ·377	9·56	·220	5·58	·205	5·207	·015	·381	·020	·508	·222	5·63	·219	5·558	·209	5·308	·005	·127	**5**
6	·192	4·88	·162	4·11	·203	5·156	013	·330	·201	5·105	U ·368	9·34	·203	5·156	·204	5·181	·016	·406	·021	·533	·198	5·023	·203	5·156	·191	4·845	·006	·152	**6**
7	·176	4·46	·144	3·66	·180	4·57	·015	·381	·199	5·048	T ·358	9·09	·180	4·57	·201	5·105	·017	·431	·023	·584	·176	4·462	·188	4·77	·174	4·41	·007	·177	**7**
8	·160	4·06	·128	3·24	·165	4·187	·016	·406	·197	4·997	S ·348	8·83	·165	4 187	·199	5·048	·019	·482	·024	·609	·157	3·987	·172	4·36	·159	4·038	·008	·203	**8**
9	·144	3·66	·114	2·89	·148	3·753	·019	·482	·194	4·921	R ·339	8·60	·148	3·753	·196	4·972	·020	·508	·025	·635	·139	3·528	·156	3·96	·146	3·70	·009	·228	**9**
10	·128	3·24	·101	2·565	·134	3·40	024	·61	·191	4·845	Q ·332	8·43	·134	3·40	·193	4·921	·022	·558	·027	·685	·125	3·167	·141	3·575	·133	3·376	·010	·254	**10**
11	·116	2·94	·090	2·28	·120	3·04	·029	·736	·188	4·777	P ·323	8·19	·120	3·04	·191	4·845	·024	·609	·028	·711	·111	2·815	·125	3·167	·125	3·167	·011	·279	**11**
12	·104	2·642	·080	2·03	·109	2·768	·034	·863	·185	4·697	O ·316	8·02	·109	2·768	·189	4·798	·025	·635	·029	·736	·099	2·514	·109	2·768	·117	2·967	·012	·304	**12**
13	·092	2·336	·071	1·79	·095	2·413	·036	·914	·182	4·620	N ·302	7·67	·095	2·413	·185	4·697	·027	·685	·031	·787	·088	2·235	·094	2·387	·10	2·54	·013	·330	**13**
14	·080	2·03	·064	1·625	·083	2·108	·041	1·041	·180	4·57	M ·295	7·48	·083	2·108	·182	4·620	·028	·711	·032	·812	·078	1·981	·078	1·981	·090	2·28	·014	·355	**14**
15	·072	1·828	·057	1·447	·072	1·828	·047	1·143	·178	4·513	L ·290	7·36	·072	1·828	·180	4·57	·031	·787	·034	·863	069	1·752	·07	1·77	·079	2·009	·015	·381	**15**
16	·064	1·625	·050	1·27	·065	1·65	·051	1·295	·175	4·437	K ·281	7·13	·065	1·65	·177	4·487	·0314	·797	·036	·914	·062	1·574	·0625	1·59	·069	1·752	·016	·406	**16**
17	·056	1·422	·045	1·14	·058	1·473	·057	1·447	·172	4·360	J ·277	7·02	·058	1·473	·173	4·335	·034	·863	·037	·939	·055	1·397	·056	1·422	·0625	1·59	·017	·431	**17**
18	·048	1·219	·040	1·016	·049	1·244	·061	1·549	·168	4·263	I ·272	6·90	·049	1·244	·169	4·288	·035	·889	·039	·990	·049	1·244	·050	1·27	·053	1·346	·018	·457	**18**
19	·040	1·016	·035	·889	·042	1·066	·064	1·625	·164	4·161	H ·266	6·75	·040	1·016	·166	4·212	·039	·990	·041	1·041	·044	1·117	0438	1·112	·047	1·193	·019	·482	**19**
20	·036	·914	·031	·787	·035	·889	·067	1·701	·161	4·085	G ·261	6·62	·035	·889	·161	4·085	·041	1·041	·043	1·092	·039	·990	·0375	·951	·041	1·041	·020	·508	**20**
21	·032	·812	028	·711	032	·812	·072	1·828	·157	3·988	F ·257	6·52	·031	·787	·159	4·038	·046	1·168	·046	1·168	·034	·863	·0344	·873	·036	·914	·021	·533	**21**
22	·028	·711	·025	·635	·028	·711	·074	1·879	·155	3·937	E ·250	6·35	·029	·736	·157	3·987	·049	1·244	·048	1·219	·031	·787	·0313	·794	·0315	·800	·022	·558	**22**
23	·024	·61	·022	·558	·025	·635	·077	1·955	·153	3·886	D ·246	6·24	·027	·685	·154	3·911	—	—	·051	1·295	·027	·685	·0281	·713	·028	·711	·023	·584	**23**
24	·022	·558	·020	·508	·022	·558	·082	2·082	·151	3·835	C ·242	6·14	·025	·635	·152	3·860	—	—	·055	1·397	·024	609	·025	·635	—	—	·024	·609	**24**
25	020	·508	·017	·431	·020	·508	·095	2·413	·148	3·753	B ·238	6·04	·023	·584	·149	3·778	—	—	·058	1·473	·022	·558	·0219	·555	—	—	·025	·635	**25**
26	·018	·457	·015	·381	·018	·457	·103	2·616	·146	3·702	A ·234	5·94	·020	·508	·147	3·727	—	—	·062	1·574	·019	·482	·0188	·477	—	—	·026	·660	**26**
27	·016	·406	·0148	·376	·016	·406	·113	2·87	·143	3·626	—	—	·018	·457	·144	3·651	—	—	·065	1·651	·017	·431	·0172	·436	—	—	·027	·685	**27**
28	·0148	·376	·012	·304	·0148	·376	·120	3·04	·139	3·528	—	—	·016	·406	140	3·55	—	—	·072	1·828	·015	·381	·0156	·396	—	—	·028	·711	**28**
29	·0136	·345	·0116	·29	·0136	·345	·120	3 04	·134	3·401	—	—	·015	·381	·136	3·452	—	—	·076	1·930	·013	·330	·0141	·357	—	—	·029	·736	**29**
30	·012	·304	·010	·254	·012	·304	·126	3·192	·127	3·217	—	—	·013	·330	·128	3·243	—	—	·080	2·03	·012	·304	·0125	·316	—	—	·030	·762	**30**
31	·0116	·29	·008	·203	·010	·254	·133	3·376	·120	3·04	—	—	·012	·304	·120	3·04	—	—	—	—	·011	·279	·0109	·276	—	—	·031	·787	**31**
32	·0108	·274	·0079	·199	·009	·228	·143	3·626	·115	2·917	—	—	·011	·279	·116	2·942	—	—	—	—	·009	·228	·0101	·256	—	—	·032	·812	**32**
33	·010	·254	·007	·177	·008	·203	·145	3·677	·112	2·840	—	—	·010	·254	·113	2·866	—	—	—	—	·008	·203	·0094	·238	—	—	·033	·838	**33**
34	·009	·228	·006	·152	·0076	·192	·148	3·753	·110	2·79	—	—	·0095	·241	·111	2·815	—	—	—	—	·007	·177	·0086	·218	—	—	·034	·863	**34**
35	·008	·203	·0056	·142	·005	·127	·158	4·013	·108	2·743	—	—	·009	·228	·110	2·79	—	—	—	—	·0069	·175	·0078	·198	—	—	·035	·889	**35**
36	·0076	·193	·005	·127	·004	·101	·167	4·237	·106	2·692	—	—	·0075	·19	·106	2·692	—	—	—	—	·0061	·154	·007	·177	—	—	·036	·914	**36**

and both of the legs must come exactly opposite.

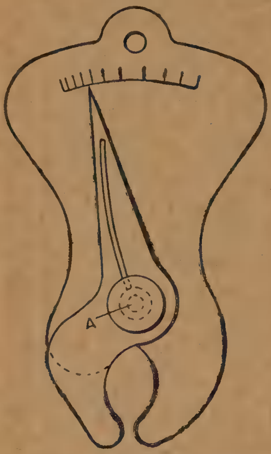


Fig. 11.—Complete Recording Gauge

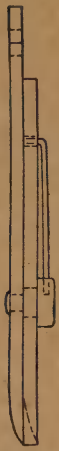
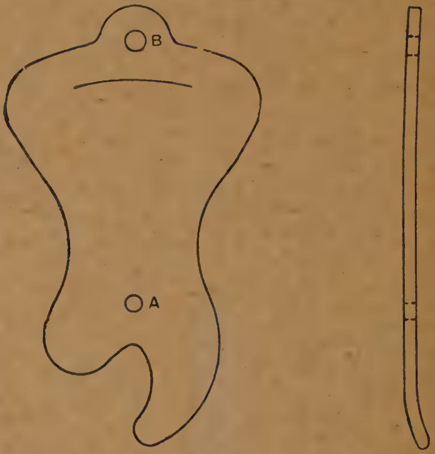


Fig. 12.—Edge View of Recording Gauge



Figs. 13 and 14.—Front and Edge View of Body of Recording Gauge

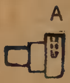
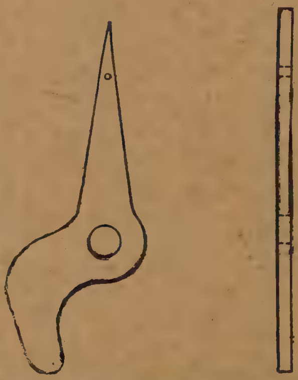


Fig. 17. — Rivet for Recording Gauge



Figs. 15 and 16.—Front and Edge Views of Pointer

The needle or pointer (Figs. 15 and 16) requires similar treatment to that given the body. The rivet (Fig. 17) should be made from cast-steel, or very good mild steel, and a hole A must be drilled in the head for the reception of the spring wire, the other end of which fits into a small hole drilled in the needle. The spring is required for the purpose of closing the jaws of the gauge, and to keep them pressing on the material being measured. If the rivet is fixed in the position indicated at A (Fig. 11), and a piece of stiff steel wire (cut from a hat-pin) inserted—one end in the rivet and the other end in the hole in the pointer—this will act as an efficient spring and keep the jaws of the instrument closed.

After all the parts have been put together, the scale (see Fig. 11) must be marked out. The easiest method of doing this is to obtain small pieces of wire of each size, try them between the jaws of the gauge, and then carefully mark on the scale the exact position indicated by the pointer. Numbers must, of course, be engraved or stamped on.

Grinding, Setting, and Stropping Razors

Grinding.—Old razors that have been ground time after time become soft and useless, and cannot be made to hold a shaving edge, as the least touch when wiping them takes it off again. Some of the new razors are no better than the old ones in this respect.

The greatest care must be taken, when grinding a razor, not to soften the edge, which must be laid on very lightly indeed, especially when the razor is extra hollow-ground. The grindstone is best run in water, but where this is inconvenient, a pan of water must be kept close to the emery stone and the blade plunged in constantly, so that it can be kept cool. Grind evenly up to a thin edge without getting the edge through in places. If the edges are snipped, lightly draw across the stone in an oblique direction, first one side then the other, keeping the edge away from the body.

It is a first-rate rule never to grind a razor if it does not really need it; it will be found that many of the hollow-ground razors only require setting.

A useful size of emery stone for the plain or common hollow-ground razor is from 8 in. to 10 in. in diameter, and for the extra hollow-ground from 4 in. to 6 in., as it is only the edge that needs grinding thin, when too thick to set.

Small leather bobs or glazers, 1½ in., 2 in., and upwards, will be required for cleaning the hollows when tarnished or rusty. An easily made spindle for small bobs (see Fig. 1) can be fixed on a small bench, and needs to be driven from shafting or from a treadle-driven flywheel. To make the metal bridges A, take two pieces of iron about 1 ft. by 1½ in by ⅜ in., and bend to the shape shown in Fig. 2. Drill a hole in each end to take screws for securing them to the bench, and a hole in the centre of the top for a ½-in. set-screw, which holds the wooden blocks B; these blocks are of hardwood, and are cut to about 6 in. by 3 in. by 3 in. The spindle block C is also made of hardwood, about 6 in. long by 1½ in. thick, with a hollow in the centre for the spindle to rest on, and reduced to 3 in. across the top by cutting 1½ in. from each side, leaving enough at the base to take a screw at each end for securing it to the bench (see Fig. 3.) For the spindle, procure a piece of round mild steel 1 ft. 8 in. long by ½ in. in diameter; have one end turned and screwed about 8 in. or 9 in. to take a ⅜-in. nut, and both ends tapered to a point to run in the holes in the wooden blocks B. Put a ⅜-in. washer on the screwed end up to the shoulder, then the small leather bob or glazer, then another washer, closing them up together with the nut. When a different size bob is required, it is thus easily changed. At the other end fix a wooden pulley about 2 in. in diameter. If the spindle is fixed on the bench, a hole will have to be cut throguh it large enough for the driving blet to run clear. Fig. 4 shows the alternative shape for the wooden blocks B, the height being 4 in. in front for a distance of 2 in., and the remainder 3 in. The height of the spindle block C should, of course, correspond. In a block of this shape the set-screw is out of the way of the razor scales when a razor is being glazed. It should be noted that the iron clamps must be set farther apart to allow of the blocks being removed.

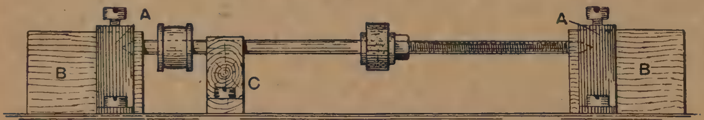


Fig. 1.—Spindle for Mounting Glazer on Bench

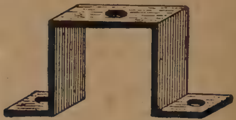


Fig. 2.—Metal Bridge

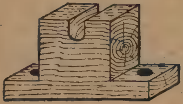


Fig. 3.—Spindle Block

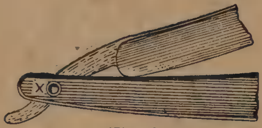


Fig. 6

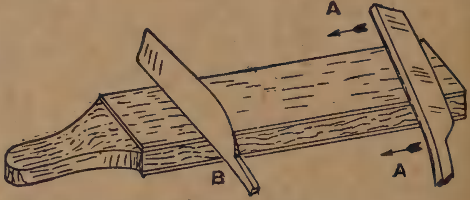


Fig. 10.—Two Positions of Razor on Strop

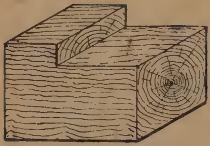


Fig. 4.—End Block of Another Shape

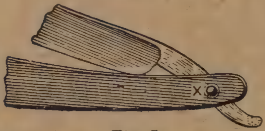


Fig. 5

Figs. 5 and 6.—Razor with Side Fall

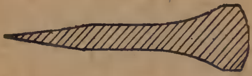


Fig. 7.—Section Through Razor Properly Set

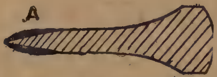


Fig. 8.—Section Through Worn Razor

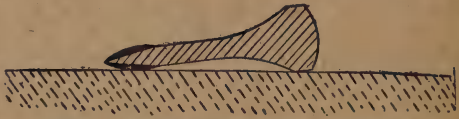


Fig. 9.—Correct Position of Razor on Oilstone

Setting and Stropping after Grinding.—Before setting the ground razor, wipe off all dirt and grease and see that there is no grit on the whetstone or hone. Dip the point of the razor blade in sweet oil, and transfer some to the whetstone; then place the blade flat on the stone, and with a succession of firm but light strokes on each side alternately from right to left, turn over, then from left to right, working from heel to point in each case, until the edge is turned up in a fine burr. Then, holding the blade at an angle, lightly skim each side of the edge across the stone to take the off burr, and afterwards draw the edge lightly across a piece of old horn razor scale. A few more light strokes from heel to point, keeping the blade flat on the stone (which must be kept clean and well oiled), should bring it to a fine edge.

Examine the blade very closely, to see if the edge is turned or rough; if so, lightly skim it off again and work up the edge until clear. A few strokes on a good strop should put a fine shaving edge on the blade. Take great care in wiping the blade, or it will have to go on the stone again. A good and simple dressing for a razor strop is to rub some tallow well into the strop, keeping the surface free from grit.

Bad Closing of Blade.—When a razor blade catches on the edge of the scale, a few light taps should be given with a small riveting hammer on the side of the rivet head nearest to where the point of the blade falls to the side (see Fig. 5, where the point of the rivet to be tapped is indicated by a cross); then, turning over, give a few taps on the side of the rivet farthest from that point, as indicated in Fig. 6, at the same time keeping the blade partly open and pressing it slightly to the opposite side. It is desirable to practise on an old razor first, until the blade can be made to fall as required.

If the scales are of horn, slightly heating them by holding in front of a fire, or dipping in hot water, will soften them, when they can be twisted just enough to allow the blade to fall in the centre; they must be held in that position till cold.

Repairing Scales.—Most of the black razor scales now used are made of a composition, and are very brittle. If a razor requires a new scale of this description it is better to put the blade in a pair of new scales, which can be bought from the manufacturers ready for the blades, together with wire and small brass washers. The same remark applies to bone scales. If a new ivory scale should be required, the method is similar to putting new scales on spring-knives; but there are no brass liners, and the holes must be exactly true with the other side. If scales in the rough are not to hand, it would be better to send the job to Sheffield to be done, or to obtain a pair of finished ivory scales.

Re-setting and Stropping. — Fig. 7 represents the section through a new razor that has been properly set, the edge being acute, and, for a considerable time, if no accidents occur, stropping before it is used will be sufficient to keep it in order. After a time, as the cutting edge wears away, the angle becomes more obtuse, as shown by Fig. 8, and the leather of the strop will not remove sufficient metal to bring the edge to the proper angle. It is therefore necessary to use an oilstone, or if in bad condition or badly notched, a grindstone first and then the oilstone. A Turkey stone is good for the purpose, as it cuts quickly and leaves a fine edge, but if one of these is not available a Washita or some other coarse cutting stone may be used first, and the edge finished on a hard stone, such as a Charnley Forest. The use of the stone is to remove the portion blacked, A (Fig. 8), and to do this the blade is placed on the stone with the back and edge resting on it as shown in Fig. 9, and rubbed up and down lengthways of the stone, both sides of the blade being rubbed alternately until the waste metal, A (Fig. 8), is removed. The sharpening on the oilstone should be discontinued, unless the edge is notched, just before the acute edge is reached, or a wire edge will be the result—that is, a thin edge of metal that will bend backwards and forwards when the blade is turned over will be formed. The oilstone should be thoroughly clean, and lard or sweet oil mixed with about a quarter of its bulk of paraffin may be used.

The razor is now ready for stropping, and a strap of buff leather, such as an old army belt, is one of the best things that can be used for this purpose. As a substitute, a piece of fairly hard leather may be glued on to one side of a piece of wood, the face of the leather being dressed with a little rottenstone and oil, and a piece of soft buff leather may be mounted on the other side of the wood. In using the strop the dressed surface is used first. The blade should be drawn back first along the leather as shown by the arrows A (Fig. 10), then turned over with the back of the blade on the strop as at B (Fig. 10), and not edge downwards, for the return stroke. A few rubs should be sufficient on the soft leather only, the dressed side being used when the razor is in bad condition. Two or three razors should be in use at a time, as it is often found that if given a rest for a week or two a blade that has apparently got out of order will then work better than ever. The strop should be used after shaving as well as before, so as to put away the razor in a good condition.

Strops.—Razor strops are of two sorts, cushion and hanging. The hanging strop is apt to put on an edge at too great an angle to the plane of the blade. The cushion strop can be kept moist with a little oil, or with a little lather from the shaving brush applied immediately before use.

Setting Safety Razors.—The now popular safety razor consists of an interchangeable thin, keen blade set in a holder provided with a guard. The principle of setting or sharpening is exactly the same as in the case of the ordinary razor, but the blade must be set in a special holder, as it is too small in itself to be properly held, in addition to the personal risk of holding a double-edged blade. Stropping-holders can be bought at cutlery shops, while there are a few varieties of cheap machines on the market for doing the stropping efficiently and rapidly. Firms that make a business of re-sharpening these blades employ an ingenious machine in which a number of blades can be held at one time in a series of clamps, there being two or perhaps three revolving buffs or rollers of different grades of fineness for respectively starting the sharpening, carrying on, and giving the final keenness.

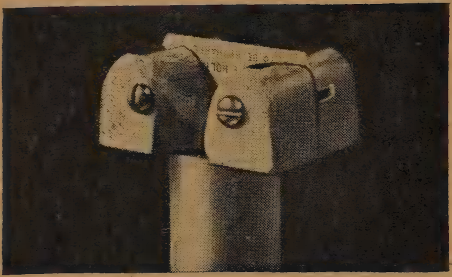


Fig. 11.—String Cutter Made from Old Safety-razor Blade

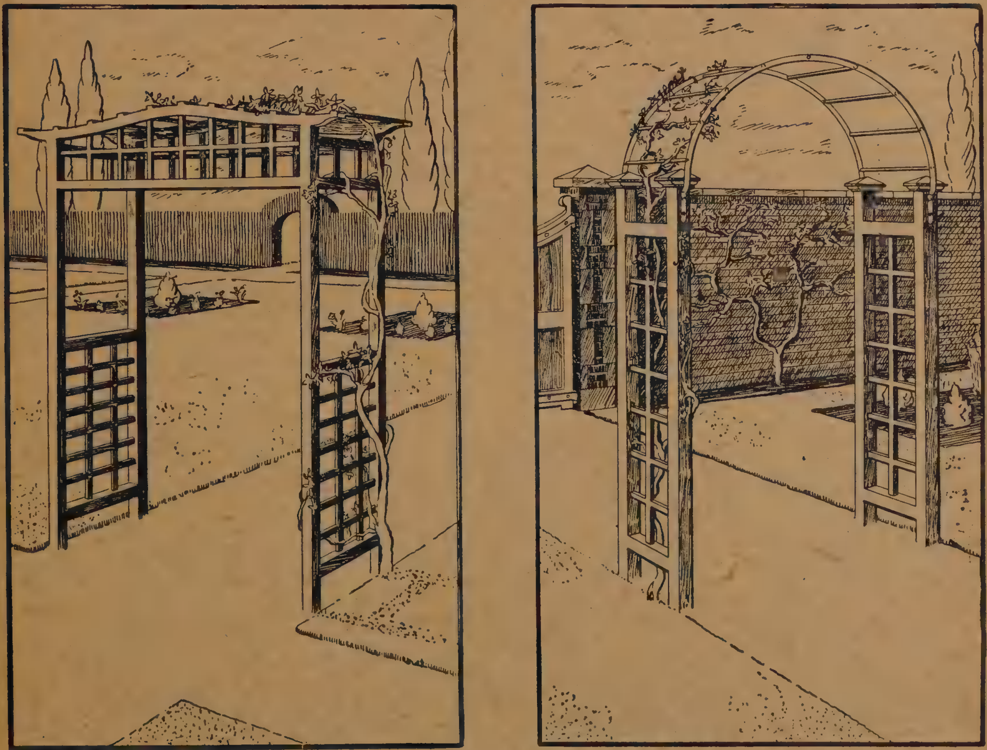
Utilising Safety-razor Blades.—Nearly everyone who uses a safety razor soon accumulates a number of blades, which, whilst not being sharp enough for shaving, can still be used for a number of useful purposes when fitted to handles, all that is necessary being to screw the blade on to a handle made of wood. This handle may be 6 in. long, $\frac{1}{2}$ in. wide, and about $\frac{3}{8}$ in. thick, the blade being screwed on the wider side. If too much blade projects over the wood, the edge is likely to snap. Some uses to which this very sharp knife can be put are: trimming photo prints; undoing stitches in seams; corn cutting; nail trimming; cutting newspapers, and rapidly opening envelopes. The blade is too brittle for use in sharpening pencils.

A flat handle is preferable to a round one, as it will not slip in the hand. An excellent handle is made from a piece of thin sheet brass $2\frac{1}{2}$ in. long and $1\frac{1}{2}$ in. wide. This is folded lengthwise and the blade inserted at one end so that about $\frac{1}{8}$ in. projects. The other end of the folded brass is tapered in width and inserted in a saw cut in a simple wooden handle, in which it is held by two screws or rivets. If a little projection (about $\frac{1}{8}$ in. or $\frac{3}{16}$ in.) is left on the front ($1\frac{1}{2}$ in.) edge of the brass, this can be turned in to prevent the blade slipping out.

A smart little string cutter for attachment to a string box can be made with a safety-razor blade. A little block of hard wood $1\frac{1}{2}$ in. high, $1\frac{3}{4}$ in. wide, and $1\frac{1}{2}$ in. deep has a valley about $\frac{5}{8}$ in. deep cut centrally in its top face at right angles to the $1\frac{3}{4}$-in. edge. Then a fine saw cut is made parallel with that edge, and into the cut the blade is inserted and then gripped with two brass screws, one each side of the valley, inserted from the front. The photograph (Fig. 11) gives the idea. In this illustration, the support underneath the string cutter is no part of the appliance.

Treillage and Trellis-work

ALTHOUGH " treillage " is but the French equivalent for " trellis," the former term has now become associated with a style of ornamental woodwork for garden embellishment consisting essentially of a lattice of uprights and horizontals, the term " trellis," being more particularly applied to the universal diamond-mesh lattice formed by the crossing of two sets of slanting members. Treillage is



Figs. 1 and 2.—Two Garden Arches

fast becoming very popular, and when covered with climbing plants gives a very ornamental effect. Deal is, perhaps, the wood that is most commonly used for work of this kind, being easily wrought, and fairly lasting in exposed positions when well painted or varnished ; oiled oak has a better effect and a longer life than deal, but costs far more. The work shown in this chapter will not be very difficult to carry out, as each example is straightforward, and no difficult joints are used.

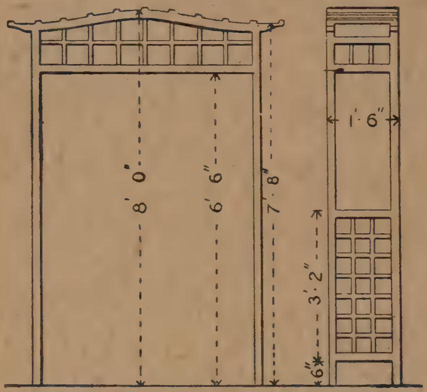


Fig. 3 Fig. 4

Figs. 3 and 4.—Two Elevations of Square-headed Arch

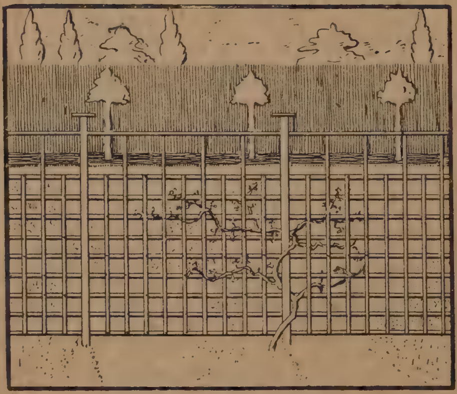


Fig. 8.—Screen

ARCHES

The arch shown in Fig. 1 is given in front and end elevations by Figs. 3 and 4, and the principal dimensions are also shown. The width of an arch of this kind will, of course, be governed by the width of the path over which it is intended to be fixed ; but the design shown could be adapted to meet almost any requirements. The principal portions of the arch should be 2 in. square in section, and the uprights should be long enough to allow of their being sunk about 1 ft. into the ground. The uprights and connecting rails are framed together with ordinary mortise-and-tenon joints. The rails which form the treillage at both the top and sides should be about $\frac{3}{4}$ in. square in section. They

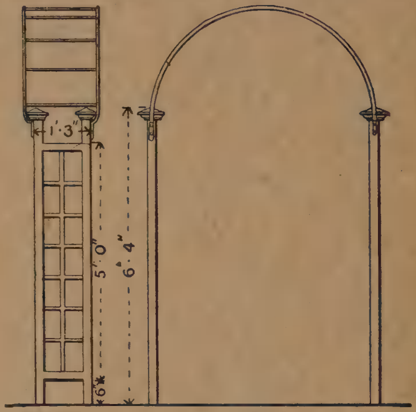


Fig. 5 Fig. 6

Figs. 5 and 6.—Two Elevations of Circular-headed Arch

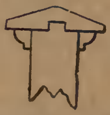


Fig. 7.—Wood Cap for Circular-headed Arch

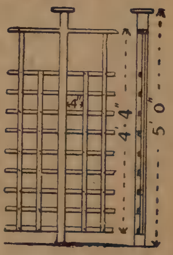


Fig. 9.—Details of Screen

are half-lapped together, and stump-tenoned into the uprights and connecting rails. In finally fixing the parts together, the principal joints may be glued and secured with wood pins; or they may simply be nailed. The top of the arch consists of a number of cross battens which are about 1 in. wide by $\frac{1}{2}$ in. thick, and are simply nailed in position.

The arch shown in Fig. 2 differs both in design and construction from that shown in Fig. 1. Front and end elevations of the arch are shown by Figs. 5 and 6, and the principal dimensions are also given. Each side of the arch is made up separately, and consists of two uprights and two cross rails, which should be about 2 in. square, and mortised and tenoned together. The space between the uprights and cross rails is filled with simple treillage which is made up with rails about $\frac{3}{4}$ in. square, half-lapped together, and tenoned into both the uprights and cross rails. Caps are fitted to the top ends of the uprights to give a finished effect, and they should be made up as shown by Fig. 7. The cap itself is 4 in. square by 1 in. thick, shaped and tenoned in position as shown, while a piece of $\frac{3}{4}$-in. moulding is mitred round the upright underneath the cap. The upper portion of the arch consists of a semi-circular iron frame. The side members of the frame are 1 in. by $\frac{1}{2}$ in. in section, and feet are formed at each end as shown, by means of which the frame is finally screwed to the uprights. The side members are connected with about nine $\frac{3}{8}$-in. round iron rods, which are riveted in position.

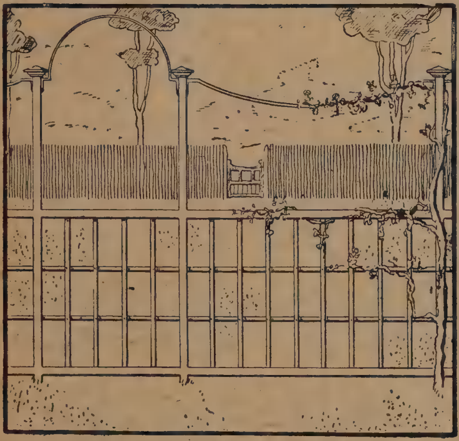


Fig. 10.—Another Screen

SCREENS

The screen shown in Fig. 8, and in detail by Fig. 9, is of very simple construction. The uprights should be about 2 in. square, and long enough to be sunk about 1 ft. into the ground. The top end of each upright is finished with a simple wood cap, which should be tenoned in position. The top rails should be about 2 in. wide by 1 in. thick, and all the remaining rails 1 in. by $\frac{1}{2}$ in. The top rail and the horizontal rails are tenoned into the uprights, and the upright rails are simply nailed to the horizontal rails while every second upright rail which extends to the top rail is tenoned into it.

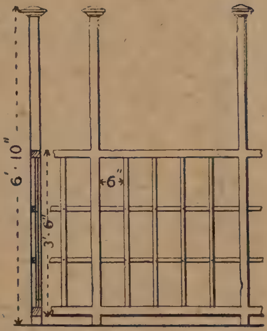


Fig. 11.—Details of Screen

The screen shown in Figs. 10 and 11 is more elaborate than the preceding one. The uprights, and top and bottom rails in this case, may again be 2 in. square in section, and the top ends of the uprights should be finished with wood caps similar to that shown by Fig. 7. The uprights and top and bottom rails are framed together with ordinary mortise-and-tenon joints, and the smaller horizontal and perpendicular rails, which are 1 in. by $\frac{1}{2}$ in. in section, should be tenoned into the uprights and rails, and nailed together. The top ends of the uprights should be

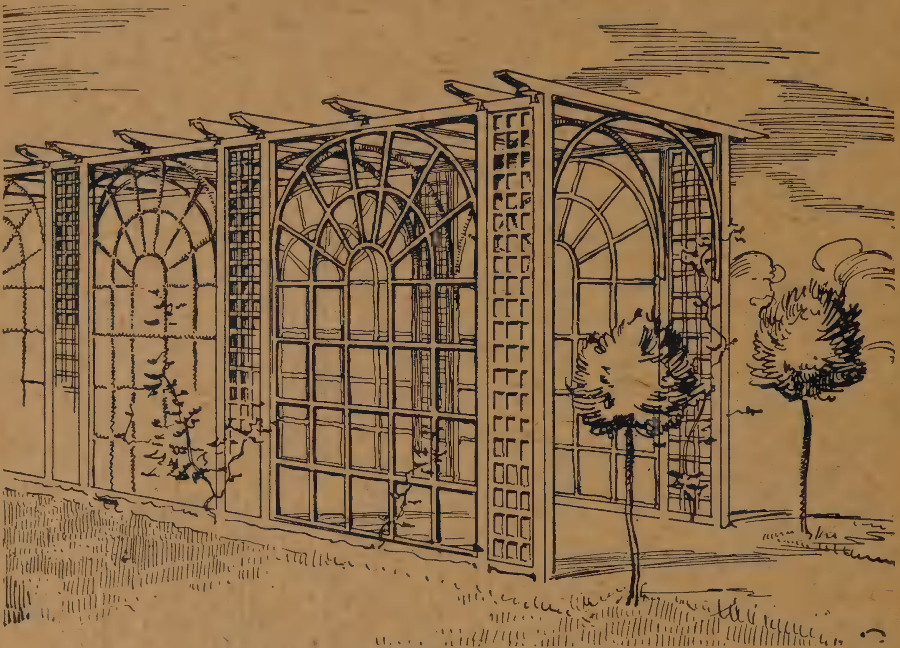
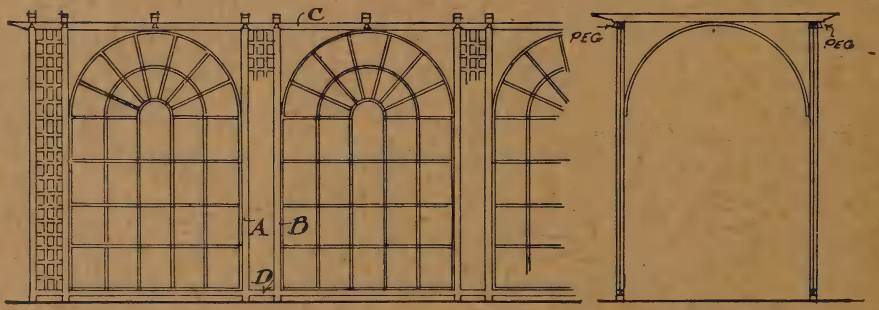


Fig. 12.—A Pergola with Treillage



Figs. 13 and 14.—Part Side Elevation and Vertical Section of Pergola

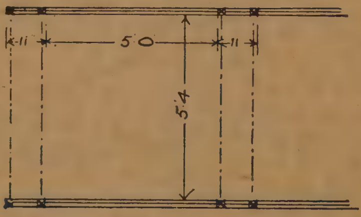


Fig. 15.—Plan of Pergola

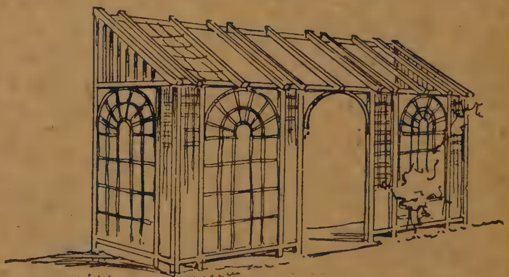


Fig. 16.—Pergola Design Adapted for Porch or Veranda

connected by iron rods, which are shaped as shown. Each rod should be about $\frac{3}{8}$ in. in diameter, and feet are formed at the ends, so that by these means the rods can be easily screwed into their proper positions.

TWO PERGOLAS

First Design.—The pergola illustrated by Figs. 12 to 15 could be introduced at one point or another in almost every garden of fair extent, and might be continued to any reasonable length. Its construction will be found to have the merit of simplicity and may perhaps be considered a trifle unusual, while the effect when partly covered with foliage will be found extremely pleasing.

Fig. 13 shows three bays of one side, with the main framework, which will need to be at least 7 ft. in height and should consist of $1\frac{1}{2}$-in. stuff, in the form of uprights in pairs, as A B, tenoned into a continuous head C, and kept apart just above the level of the ground by means of sill-pieces as at D, notched between. The lower ends of these uprights should be well tarred and bedded firmly in the earth to a depth of some 18 in. or so. The narrow panels between the uprights should have a small slip planted on to form a rebate, and be filled in with treillage, which can be of high-class material and workmanship, or simply made up with plasterers' laths. The wide spaces, which are intended to be 5 ft. across in the clear, are filled in to the geometrical design indicated, with thin lengths of pliable cane, carefully bound together at all intersections with durable galvanised or copper wire. Of course, the intersections are not intended to be halved or jointed in any way, the canes simply crossing at right angles and being secured with wire. The semicircular-headed openings rather recall in appearance the glazing sometimes introduced for windows, and sets off the straight lines of the rectilinear portions to great advantage.

The two sides of the pergola are intended to be spaced about 5 ft. 4 in. apart, being secured at this distance by cross-pieces at the top, each about 3 in. by $1\frac{1}{2}$ in., and having shaped projecting ends, spiked on to the heads of the side framings, and finished at the ends underneath with small wood pegs or wedges, as shown in Fig. 14. These cross-pieces are spaced out so as to come over each upright and also centrally over each panel of the semicircular work, or they could be arranged at regular intervals of 1 ft. or 18 in. if preferred. Placed as shown there is more diversity of effect, and the wider spaces can be bridged by a network of stout wires, over which to train the plants when they have sufficiently developed to require such support. A semicircular arch of a single piece of cane should be fitted between the uprights where indicated by dotted lines on the plan, and in the position shown on the section (Fig. 14).

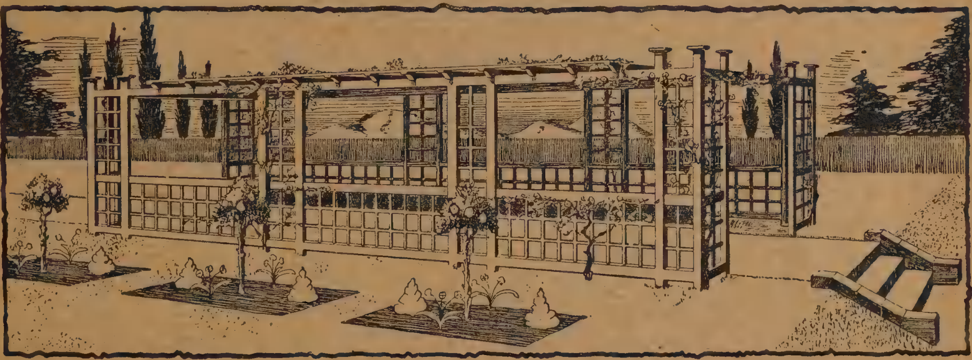
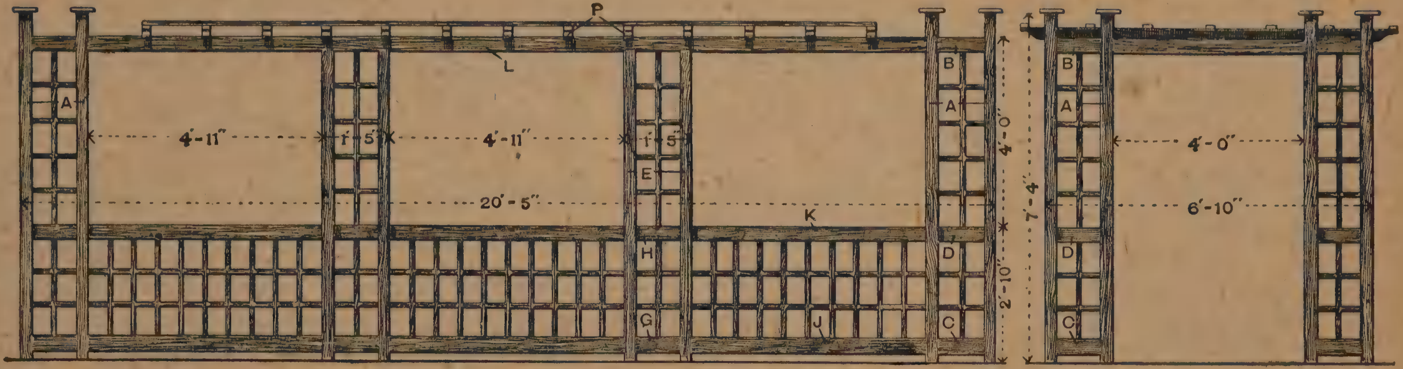


Fig. 17.—Pergola of Substantial Design



Figs. 18 and 19.—Side and End Elevations of Pergola

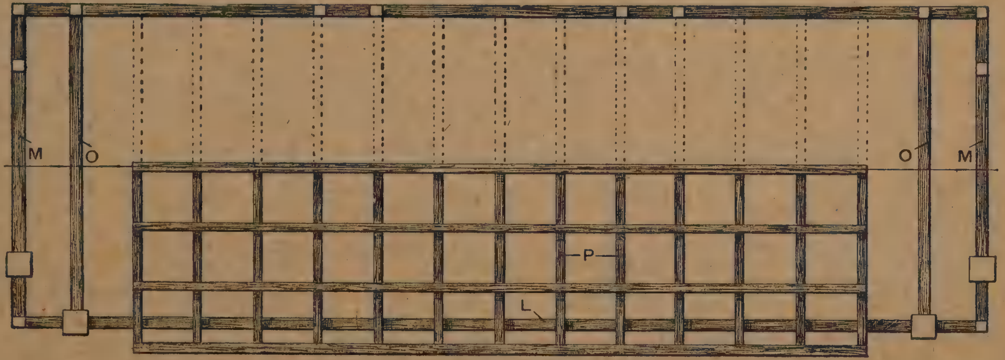


Fig. 20.—Plan of Pergola

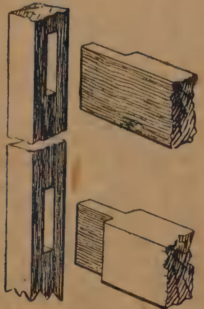


Fig. 21.—Shoulder Tenons and Bare-face Tenons on Rails

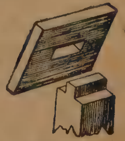


Fig. 22.—Method of Fixing Cap

Fig. 16 is given as an example of the way in which this type of work may be adapted to other garden purposes, as can be done in quite a number of different arrangements. The illustration shows one instance of a lean-to effect suitable for erecting against the wall of a house, either as a porch or veranda, and having a central opening and enclosed ends, the same main idea being equally suitable for employment in various other ways.

Second Design.—The rose pergola shown complete by Fig. **17** is altogether a more substantial erection than is the one just previously described; but simplicity has been borne in mind, and its construction will not present particular difficulty. Fig. 18 shows a side elevation, Fig. 19 an end elevation, and Fig. 20 a plan of the complete pergola. Suggestions for the dimensions are given in these illustrations, but they need not be strictly adhered to, as the structure could be adapted to suit a large or small garden, as desired. In making the pergola, it will be a good plan to build it up in sections in the workshop, to carry these to the spot where the pergola is to be erected, and finally to erect. Deal will be the best wood to use for the construction. The four end upright sections, the four inner upright sections, and the six lower sections which connect the upright sections, could be first built up separately.

The end upright sections each consist of three uprights A, which are 7 ft. 4 in. long above the ground, with an extra length of about 2 ft. for sinking into the ground, by 3 in. square in section; two top rails B, and two bottom rails C, which are 4 in. deep by 3 in. thick in section; and two middle rails D, which are 4 in. deep by 2 in. thick in section. The top, middle, and bottom rails are framed at right angles into the uprights with mortise-and-tenon joints. Ordinary double-shoulder joints are used for the top and bottom rails, and bare-face joints are used for the middle rails (see Fig. 21). The rails forming the treillage are 1 in. square in section, are half-lapped together, and are tenoned in position.

The middle upright sections each consist of two uprights E, which are 3 in. square in section, and long enough to be sunk about 2 ft. into the ground; a bottom rail G, which is 4 in. deep by 3 in. thick in section; and a middle rail H, which is 4 in. deep by 2 in. thick in section. The bottom and middle rails are framed into the uprights with mortise-and-tenon joints similar to those shown in Fig. 21; and the rails that form the treillage pattern are 1 in. square in section half-lapped together, and tenoned in position.

The six lower sections that connect the upright sections each consist of a bottom rail J, which is 4 in. deep by 3 in. thick in section; and a top rail K, which is 4 in. deep by 2 in. thick in section. Tenons which will eventually fit into the uprights of the end and middle sections are cut at the ends of these rails, and the treillage is fixed between the rails.

Holes should be prepared in the ground to receive the ends of the uprights, and the sections could then be fitted together. A long rail L is fitted along the top at each side. It is 4 in. deep by 3 in. thick in section, and is tenoned into the uprights of the end sections, and the uprights of the middle sections are tenoned into it. The end sections are connected by two outer top rails M and two inner top tails O, which are 4 in. deep by 3 in. thick, and are tenoned in position. The whole of the joints connecting the sections may then be finally fixed together, wood pins being used to secure them, although nails may be used if particularly wished. The soil around the uprights may then be returned, but it would be better if the uprights were bedded in concrete, as this adds greatly to the stability of the structure. It would also be desirable to paint the joints before finally fixing them, while ends of the uprights which are sunk into the ground could be preserved with tar or thick paint.

The top ends of the uprights of the end sections are finished with wood caps, which are 6 in. square by 1 in. thick, and are tenoned to the ends of the uprights, as shown in Fig. 22.

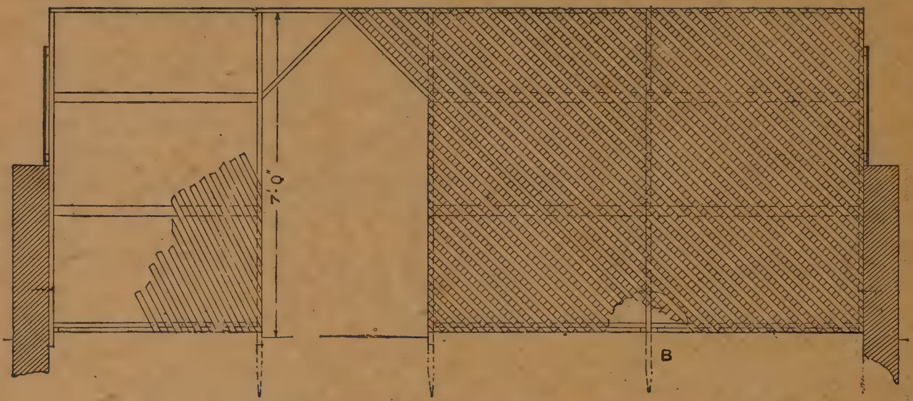


Fig. 23.—Elevation of Trellis Screen and Arch

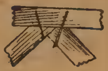


Fig. 24.—Joint at Head of Arch

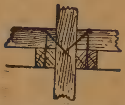


Fig. 26.—Detail at B (Fig. 23)

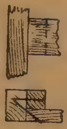


Fig. 25.—Joint at Rails and Posts

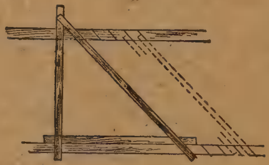


Fig. 29.—Using Template to Set Laths at Uniform Angle

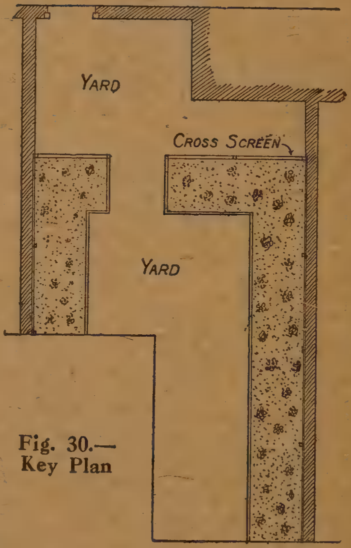


Fig. 30.—Key Plan

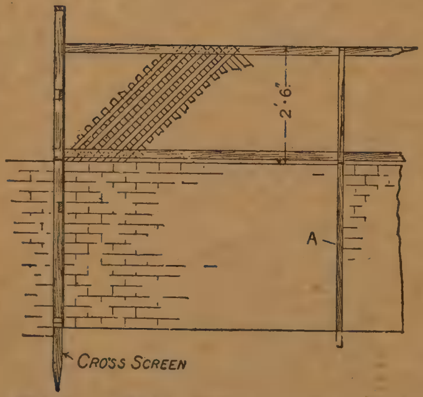


Fig. 31.—Trellis Fixed to Party Wall

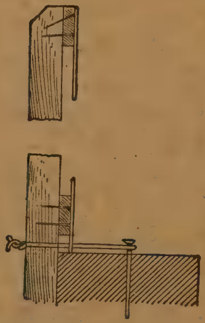


Fig. 32.—Fastening Posts to Party Wall

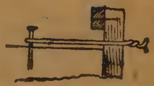


Fig. 27

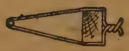


Fig. 28

Figs. 27 and 28.—Fixing Uprights to Wall

The roof is formed of thirteen rafters P, which are 3 in. deep by 2 in. thick in section. They overhang about 6 in. at the sides, and the ends are shaped as shown. The rafters are notched about $\frac{1}{4}$ in. over the top rails L, and are fixed in position with nails. The roof is completed by fixing seven battens across the rafters. The battens are 2 in. wide by 1 in. thick, and are nailed to the rafters.

Finally, the pergola should be painted with two or three coats of a colour which will harmonise with the surroundings. An oak pergola would simply be treated with boiled oil.

A TRELLIS SCREEN

The kind of trellis shown by Fig. 23 is much less popular than it used to be, largely owing to the fact that timber yards and oil shops sell expanding trellis-work so cheaply that it has become very common, and a demand has naturally arisen for something less hackneyed. The illustrations opposite show, however, a very useful and presentable example of ordinary trellis-work. But little skill is required in its erection.

The uprights, also the top and bottom rail of the cross screen, are 2 in. by $1\frac{1}{4}$ in., the remainder of the horizontals being $2\frac{1}{2}$ in. by $\frac{3}{4}$ in. The lathing should be done with plasterers' laths $1\frac{1}{4}$ in. by $\frac{3}{16}$ in., nailed with plasterers' wire nails, price 3d. per lb.; the laths cost about 1s. 4d. per bundle. The framing is put together as shown. The self-supporting uprights should be painted, dipped in tar, and driven into the ground with a heavy mallet.

Fig. 23 is a front elevation of the cross screen, and shows alternative lathing. Fig. 24 shows the joint at the top of the arch, and Figs. 25 and 26 the method of securing the horizontal rails.

Figs. 27 and 28 show the method of fastening the uprights to the wall. A 4-in. nail is driven into the centre of the wall, and the upright secured to it with fencing wire. Another nail should be driven through the upright, near the ground, into the wall. Fig. 29 shows the method of using a template for getting the correct angle of laths. Nail some laths together adapted to the correct angle, slide along and mark off with lead pencil.

Fig. 30 is a key plan showing the arrangement of the trellising to back yards and low party walls. Fig. 31 is an elevation of the trellising fixed to a party wall. The upright at A is to be fixed flat against the wall to receive the joint at the rails. Fig. 32 is a detail section of the wall trellising uprights fixed as described.

Wardrobe Door Not Closing

A COMMON complaint in the case of none too reliable furniture is that the door of a wardrobe swells and refuses to shut. To plane the door to fit is a great mistake until the following method has been tried. On examination it will often be found that the top and bottom of the door have not swelled, but on looking along the edge a distinct bend can be seen. This is caused by the thin board that covers the back of the mirror swelling and forcing the frame of the door outwards. Take out all the screws or sprigs along both sides of the back board, leave the end ones in, and then try and shut the door. It may be found that, by pressing the centre of the door towards the hinges, the door will fit into its place, and if this is so the rest is easy. With a bradawl slanting towards the edges of the door, make new holes for the screws; then the stiles of the door will be drawn inwardly as the screws are driven home. Begin at the centre of the door.

Boat Building

THE first example described in this chapter is a flat-bottomed punt-like boat or canoe suitable for a pond or smooth-water river. The chief points in view are cheapness but safety, the work requiring ordinary skill, and necessitating the use of only a few woodworking tools.

A 12-FT. FLAT-BOTTOMED BOAT

The design shown by Fig. 1 is for a boat 12 ft. long with a beam or width of 3 ft. 1 in., and a depth of 9 in. at the middle and 1 ft. at each end; but these dimensions may be modified a little if required.

Lining-in or Laying-off.—Having decided on the size of boat, begin by lining-in (known as laying-off), on a suitable floor, the sheer plan (Fig. 1) as shown, marking the bottom line with a straight-edged board, representing the under-side of the boat's bottom planks; another line $\frac{7}{8}$ in. above that shows the inside of the bottom planks. Now line in the stem post C and stern post D, which are shown fitting on the bottom planks, the dotted line representing the inside boundary, and the plain line the rebate, which is cut in $\frac{1}{2}$ in. deep to receive the side planks. The rebate line is $1\frac{1}{2}$ in. from the ends of both the stem post and stern post. Next divide the length of the craft into equal spaces by lines at right angles from the bottom, about 2 ft. apart, as shown by X (the centre one) and A and B.

The top or sheer line E should now be lined in by bending a spruce batten, about 14 ft. long by $\frac{5}{8}$ in. wide and $\frac{1}{2}$ in. thick, to a fair sweep as shown, holding it fair by means of nails driven into the floor, each edge of the batten at each sheer height. In Fig. 1 the sheer height at each end of the boat is 1 ft. from the bottom, and at X the height is 9 in. At each part A the height is $9\frac{1}{4}$ in., while at B the height is $10\frac{1}{4}$ in. in each case.

The sheer lined in, mark the position of the floorings F and knees G as shown, the knees being $1\frac{1}{8}$ in. thick, and the floorings $2\frac{1}{4}$ in. wide by $1\frac{1}{4}$ in. deep.

Starting the Building.—The sheer plan is now finished, and building proper can proceed by obtaining three spruce boards or planks each 12 ft. long by 7 in. wide and $\frac{7}{8}$ in. for the bottom. Plane these up, making the edges straight and square, and place them together as shown in Fig. 2. Two more planks, each 10 ft. long by 8 in. wide and $\frac{7}{8}$ in. thick, treated in the same manner, form the wing pieces of the bottom as shown. Keep the planks close together by nails temporarily driven through into the floor, so that they can be drawn with a pair of pincers.

Now mark a straight line through the centre of the middle plank, representing the centre of the boat, and divide the length into six equal spaces by lines at right angles to the centre line, and 2 ft. apart, as shown by X X, A A, and B B.

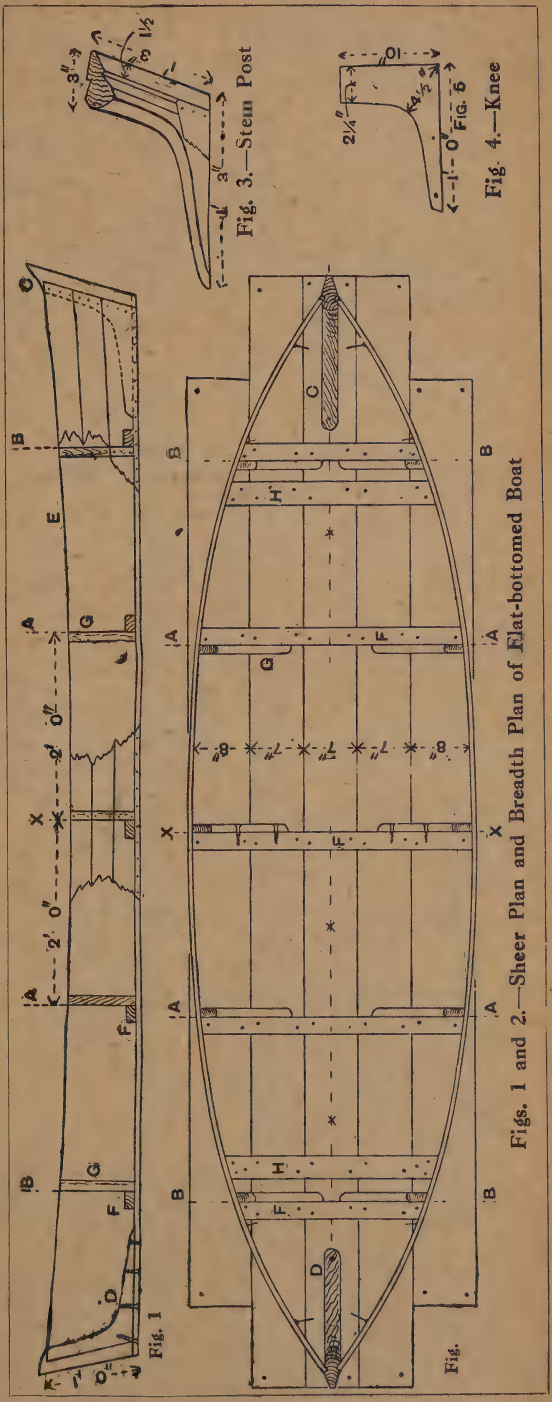
This done, the half breadth of the boat is marked at X, and a batten run to a fair sweep through this spot to the end of the boat gives the boundary line of the bottom of the boat. The inner line in

Fig. 2 shows this, the outer line representing the outside of the side planks. The half breadths in Fig. 2 are as follows: X X is 1 ft. 6 in., A A each 1 ft. 5 in., and B B each 1 ft. Both ends of the boat from X are alike in breadth and depth.

The boundary line now marked, line in the position of the floorings F, and then, taking up each plank separately, saw and plane it square to the boundary line, and replace without nailing. The planks all finished, the stem post C and stern post D are next taken in hand. These members are already lined out on the sheer plan, and the required shape could be cut out of cardboard, from which the members proper could be lined out on a piece of 2-in. English elm. The size of both the stem post and stern post is given in Fig. 3, the bottom and front or face being planed square, and the rebate cut $1\frac{1}{2}$ in. from the face and $\frac{1}{2}$ in. deep. The front is planed down to $\frac{3}{4}$ in. thick, beginning from the rebate line. To obtain the correct angle to which the rebate should be cut, place the posts in position on the middle plank as shown in Fig. 2, and mark the bottom with a pencil along the boundary line. The rebating complete, lift the middle plank, and secure both the stem post and stern post with $2\frac{1}{2}$-in. brass screws No. 14, as shown in Fig. 1.

Next replace the centre plank, and temporarily fasten to the floor with nails as before, keeping clear of the flooring marks. Then lift the other planks, well paint the edges, replace closely, securing to the floor as before, and at the ends of the planks nail them together (see Fig. 2) with 2-in. and $2\frac{1}{2}$-in. galvanised wire nails, first boring the outside plank to receive the nail, so as not to split the timber.

The Knees.—The bottom is now in position to receive the frames, which are formed by securing knees



Figs. 1 and 2.—Sheer Plan and Breadth Plan of Flat-bottomed Boat to the floorings or cross-pieces F. This is shown at X (Fig. 2) and by Fig. 5, which is a cross section of the craft complete. Fig. 4 is a dimensioned sketch of the knees, which may be of crooked oak, English elm, or larch butt $1\frac{1}{8}$ in. thick. If good grained oak is obtainable, the heads of the knees may be reduced from $2\frac{1}{4}$ in. to about $1\frac{5}{8}$ in. wide. Ten knees, five each side, will be required, and a cardboard pattern should be made from which all could be moulded and cut out. Having all the knees cut, obtain five floorings of spruce or larch $2\frac{1}{4}$ in. wide and $1\frac{1}{4}$ in. thick, bevelling the ends and making the length of each to suit its respective place already marked on the bottom of the boat. Then plane two of the knees straight and square, and fasten them, one at each end, to the centre flooring X, as shown in Fig. 2, with $2\frac{1}{2}$-in. brass screws No. 14. The knees now attached to the flooring form a frame as shown in Fig. 5, which is fixed in position with 2-in. brass screws No. 14 through the flooring into the bottom planks. The screw-heads may be sunk for about $\frac{1}{8}$ in. to bring the points flush with the bottom of the boat.

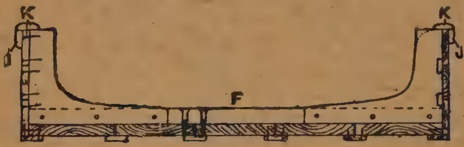


Fig. 5.—Cross Section Through Flat-bottomed Boat

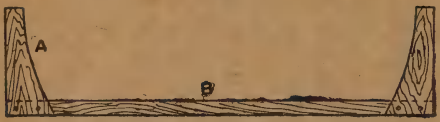


Fig. 6.—Cross Section Through Flat-bottomed Boat, with Different Side Frames

It will be seen by referring to Fig. 2 that the backs of the other knees require bevelling to the curve of the sides of the boat, and when this is done they are secured and fixed in the positions already marked in the same manner as the previous one. A wide flooring or brace H is shown in Fig. 2 at each end of the bottom. This is 3 in. wide and 1 in. thick, and is to tie the narrow ends of the wing planks, being secured to the bottom as shown with 2 in. screws.

The side frames are shown knee shape, cut out of crooked oak, elm, or larch; but if difficulty is experienced in obtaining these crooks, they may be wrought out of straight-grained timber as at A (Fig. 6), and secured to the flooring B, which is 2 in. by $1\frac{1}{4}$ in., with brass screws or copper nails clinch-fastened, as in Fig. 7, in which figure C shows the bottom planks of the boat. The side frames may be of $\frac{3}{4}$-in. oak or elm 9 in. long, having a width of 4 in. at the bottom and $1\frac{1}{2}$ in. at the top.

Side Planks.—The crank is now in frame ready to receive the side planks, which may be of $\frac{1}{2}$-in. larch, English elm, or spruce, and for convenience it could be placed on a couple of trestles, the temporary nails holding the bottom to the floor being drawn and the holes plugged up at once. The plugs should be made of soft wood, dipped in paint, and driven up tight and cut flush.

Figs. 1 and 5 show three side planks, which are narrow to facilitate bending; but if a steaming chest is available, the planks may be wider, having two each side in place of three, and may be $\frac{5}{8}$ in. thick. The planks are of equal width, therefore divide the depth of each knee and the ends, from sheer to the bottom of the boat, into three equal spaces.

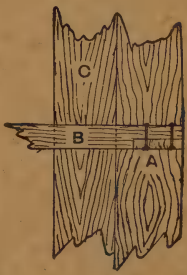


Fig. 7.—Straight-grained Side Frame Secured to Floor

Begin with the bottom plank, making the bottom edge straight and the top edge a fair sweep, corresponding in width to the spaces already marked on each knee. Having planed it up, line another plank by it for the corresponding one on the opposite side of the boat; and before nailing it on, the bottom edge of the second plank up should be lined to the sweep or curve of the top edge of this, the first plank. This will ensure a close-fitting joint when fixing on each succeeding plank.

Then fix to the bottom (see Figs. 1 and 5) with $1\frac{1}{2}$-in. galvanised wire nails, and to the knees with 2-in. nails, spacing the bottom nails about 2 in. apart; and, beginning at the middle, work towards the ends of the boat, taking care that the ends of the plank are not too hard on the end of the rebate, as this will cause the plank to buckle and prevent it nailing close to the bottom. Secure the ends of the plank into stem post and stern post with $1\frac{1}{4}$-in. brass screws No. 9, first boring the plank ends with a spoon bit to avoid splitting them. A thick layer of white lead, into which is mixed a little old thick varnish, should be placed under the plank ends before screwing home. Countersink for the screw-heads with a rose bit. Continue in this manner with the other planks, well painting the joints until the boat is planked up. A couple of small cramp screws will be found useful to hold the planks in position while nailing.

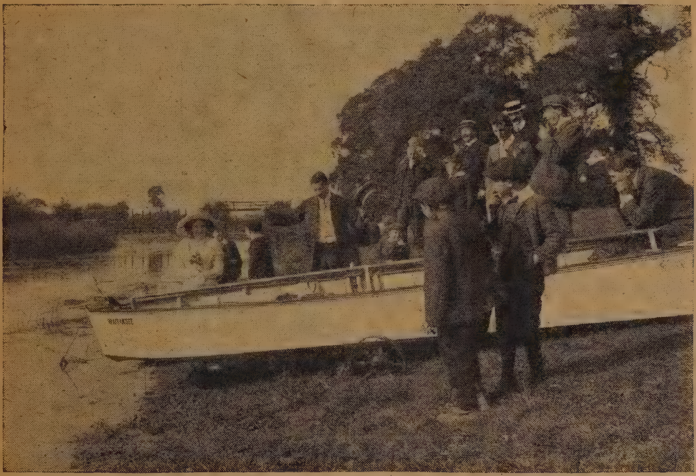


Fig. 8

Fig. 9

Figs. 8 and 9.—Photographs of Flat-bottomed Boat of Modified Design

Deck.—If a deck is desired, canoe fashion, the beams to carry it should be placed across the craft and nailed to the knee heads, and the deck planks, about $\frac{1}{2}$ in. thick, should run lengthwise. The deck beams may be of spruce 1 in. thick and about 2 in. deep at the crown, and should have a camber, or round top edge, of about $1\frac{1}{2}$-in. rise in 3 ft. Line all the beams from the first one struck out, setting out from the centre of the length of each one, so as to ensure a fair deck at the crown or middle line of the deck.

For an open boat, a larch or elm rubber J (Fig. 5) 1½ in. deep and ½ in. thick could be nailed to the top plank, forming a gunwale, and a capping piece K about 1 in. wide by ⅜ in. thick nailed over that gives a finish to the gunwale.

Chafing Battens.—The craft should now be turned upside down, and chafing battens of spruce, 2 in. wide and ½ in. thick, nailed over the bottom joints, as shown in Fig. 5, with 1¼-in. wire nails, after well coating with thick paint.

If the builder is doubtful of his joints in the side planks similar battens may be placed over them. Another method, giving more labour, but ensuring a neater job, is to have the side battens inside the boat, by letting them into the knees before placing on the planks, as shown to the right of Fig. 5.

Finishing.—The battens on, the building is completed, and any uneven places should be smoothed down and glass-papered, and a coat of good lead paint given, after which any slightly open joints may be stopped with white lead putty. Two or three more coats of paint should be given, finally finishing in white or French grey.

On placing afloat, the craft may be not absolutely water-tight at first; but if submerged for a few hours it should take up, providing the joints are neatly made. Where obtainable, brass screws and galvanised nails should be used; but if plain ones are used they should be dipped in red-lead paint before inserting.

A paddle may be made out of 1¼-in. spruce, the length being about 4 ft. 6 in., the blade being 2 ft. long by 5 in. wide.

The seating arrangement can be fixed to meet individual requirements. For the floorboards, loose gratings are generally placed between the floorings of the boat.

A 17-FT. BOAT MODIFIED FROM THE FOREGOING

Figs. 8 and 9 on the preceding page show a boat built by Mr. H. E. Kemp from the foregoing instructions, but modified in several points. It has a point at the stem only, with a square stern. Instead of screwing the knees or the ribs to the sides of the flooring, these are mortised, and secured with two 3-in. No. 16 screws, one put in from each side. Mahogany ⅝ in. thick is used for the sides, put on all in one piece, securing the side first to the stem post, and working to the stern. The sides are 18 in. at each end and 15 in. at the middle, giving the boat plenty of freeboard. A seat 18 in. wide is fitted at the back, with a cupboard in the front, and there are two pairs of rowlocks, two seats in the middle, and one small seat at the front end. The boat is 17 ft. 2 in. long, and 3 ft. 8 in. wide; and it conveniently accommodates seven persons, although as many as ten persons may be carried.

A KNOCKABOUT CANADIAN - TYPE CANOE

Figs. 10 to 12 are sheer profile, plan, and half-body plan respectively of a knockabout canoe of the Canadian type. It is 13 ft. long by 3 ft. 5 in. beam, extreme, and 1 ft. 1 in. deep 'midships from the top of the keel to the top of the gunwale. There are many ways of building canoes, and many woods with which they are constructed. As will be seen, this canoe is double-ended—that is, each half from section 5 to each stem is alike. The canoe is fore and aft carvel-built of ⅜-in. yellow pine, with bent timbers or ribs closely spaced. This style renders the canoe easily repairable if it is holed, etc.

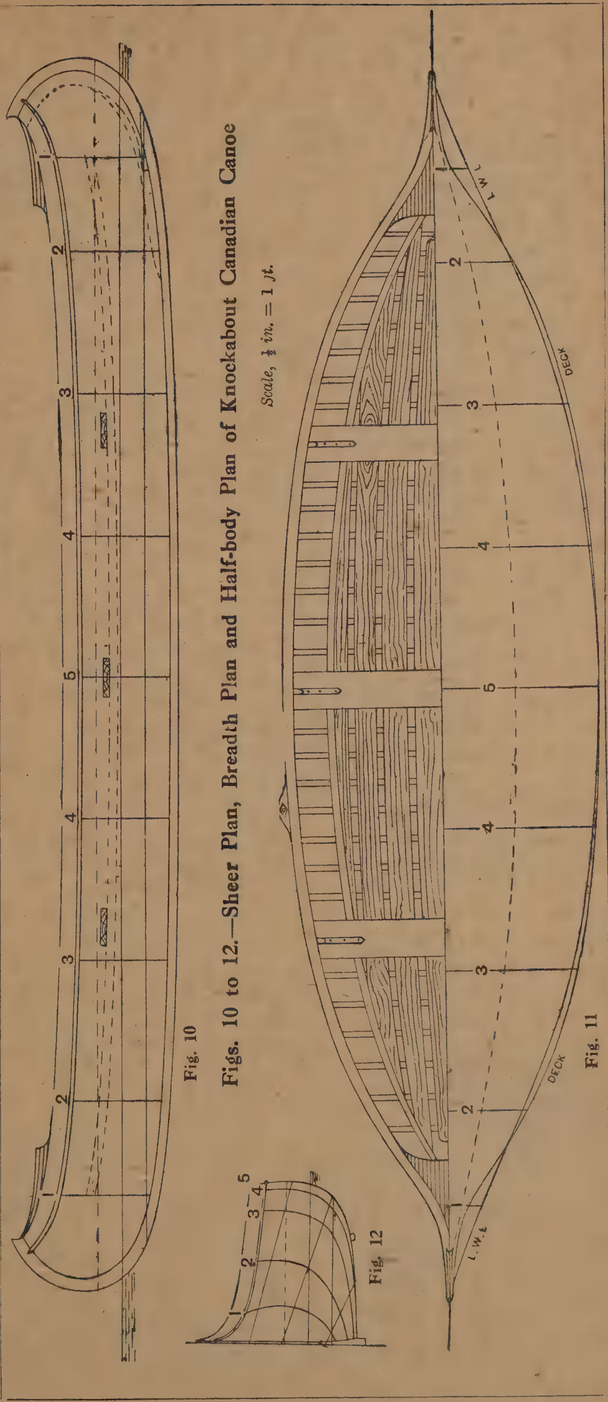
When starting to build, lay down full size the sheer profile, the sections being spaced from No. 5 to No. 2 at 1 ft. 6 in. apart; No. 2 and No. 1 are 1 ft. apart, and No. 1 to extreme end also measures 1 ft. The water lines are 3 in. apart. Mark the sections and scarf of the stem which fits on the keel, and make thin moulds of the stems and dead-woods and lower edge of the keel with which to shape the keel-plank on which the canoe is built. This plank receives the keel.

The body plan (Fig. 11) is then laid down full size, less the thickness of planking,

⅜ in. all round, and moulds of ⅝ in. spruce are made and numbered. The keel-plank being fixed in position, the keel, of oak 1½ in. square, is steamed and bent to shape on it. The keel stands out 1⅛ in. below the garboard strake to protect the bottom.

The stems, of English oak, shaped as shown, are 1½ in. thick and moulded 3 in. to take the fastening of the wood ends. The inbreast or keel apron, to which the garboard strake is secured, is of rock elm 3 in. wide and ⅜ in. thick; it is nailed to the keel, and extends from stem to stem, the deadwoods fitting on it. They are through-fastened to the keel and stem, forming a brace.

The section moulds being fixed to their respective places, and the rebating completed, temporary ribbands, about 4 in. apart, are put round the moulds from end to end. They are about ¾ in. square, of pitch pine or spruce, and are screwed to the moulds. The timbers are then steamed and bent to shape, being temporarily tacked to the ribbands. They extend from gunwale to gunwale, and are nailed to the keel at the feet. The timbers are 7/16 in. by ¼ in. deep, of rock elm or good English ash, and are spaced 3 in. from centre to centre. The ribbands are then gradually taken off, the planking taking their place, a spiling of the shape being necessary, so as not to force them into position. The widest plank need not exceed 3½ in. in width, and should be through-fastened at the top and bottom edges with light copper nails clinched on small rooves.



Figs. 10 to 12.—Sheer Plan, Breadth Plan and Half-body Plan of Knockabout Canadian Canoe

Scale, ¼ in. = 1 ft.

A small elm rubber, ¾ in. square and rounded on the outside, is placed under the top strake. When the planking is completed the section moulds are removed.

The gunwales are of rock elm 1 in. square 'midships, tapering a little to each end. The risings on which the thwarts lie are 6 in. down and are 1 in. wide by ½ in. thick, being through-fastened at alternate timbers. The thwarts are of mahogany 4½ in. wide and ¾ in. thick.

Two oak knees are fitted to each thwart. They are 7 in. on the foot and 2 in. at the head and ⅝ in. thick. The small decks at each end form a seat from which to paddle; they look well if laid in 1-in. widths of pine and mahogany alternately, ⅜ in. thick.

The flooring boards are of ⅜-in. spruce battens, about 3 in. wide, shaped as shown in Fig. 11. A rowlock chock is fitted outside each gunwale 1 ft. from the edge of the thwart, so that the canoe can be rowed as well as paddled, but two 6-ft. paddles are essential. A bilge piece, about 6 ft. long and ⅝ in. square, in the centre, tapering to each end and screwed to planking, is a protection to the canoe when beaching, etc.

The inside may be varnished, and the outside painted white, with the rubber painted black. The weight of the canoe complete is about 90 lb. to 100 lb.

A 12-FT. CANVAS CANOE

Two distinct types of canoe will be described in the following pages—a 12-ft. canvas canoe and a 9-ft. collapsible canvas canoe, but the instructions and methods of procedure given are applicable for building canvas boats in general, the size of scantling being slightly increased for larger boats.

For the 12-ft. canoe, first line out or lay off the boat full size on a suitable floor, beginning with the sheer plan or profile, as shown by Fig. 13, and breadth plan (Fig. 14), to the length, depth, and breadth desired, using the bottom of the keel, which is shown straight in this case, as a base line. Begin by striking two lines 1¼ in. apart, representing the top and bottom edges of the keel (see Fig. 13), and at the fore end, line in with a thin batten the curved stem about 3 in. wide, so as to scarf on top of the keel as shown. Then mark in the fore deadwood F D, which braces the stem and keel. At the other end line in the stern post S P and deadwood D, fastening as shown, and then line in the curved top line, known as the sheer. The depth at each end should be 1 ft. 3 in. from the bottom of the keel, the depth 'midships being 1 ft. The profile being thus lined in, put the keel in hand, making it 1¼ in. deep by 1 in. thick, of oak or rock elm, and then proceed to make thin moulds to the shape of the stem and stern-post, by which these members are marked and cut out of 1-in. crooked oak. Before securing the stem and stern-post to the keel, these members are planed down to ⅝ in. thick on the face and back respectively, starting from the rabbet (rebate) line (see Figs. 13 and 15). When the stem and stern post are nailed to the keel, the deadwoods are fitted and through-fastened with copper nails, clinched on rooves or burrs, thus completing the keel frame.

Fixing Keel Frame on the Stocks.—The next operation is to fix the keel frame on the stocks, which may be in the shape of a plank on edge, or blocks spaced at regular intervals under the keel. If building only one boat, a simple way of making stocks is to obtain five pieces of spruce scantling, 1 ft. 8 in. long and 3 in. square, and fix them upright as at U (Fig. 16), one at each end of the boat, and the others in alignment at equal distances apart. This is shown in elevation in Fig. 13, and in cross section in Fig. 16, the uprights U being secured with spruce stays S 1½ in. square, which are nailed to the floor as shown. A groove to receive the keel is formed by nailing pieces on ½-in. spruce on the uprights each side of the keel; Fig. 16 shows the keel in the groove. The stocks completed, the keel frame is placed on them, and small stays X (Fig. 13) from the keel to the uprights prevent it rising off the stocks. The stem and stern post should now be stayed perfectly upright from the roof of the shed.

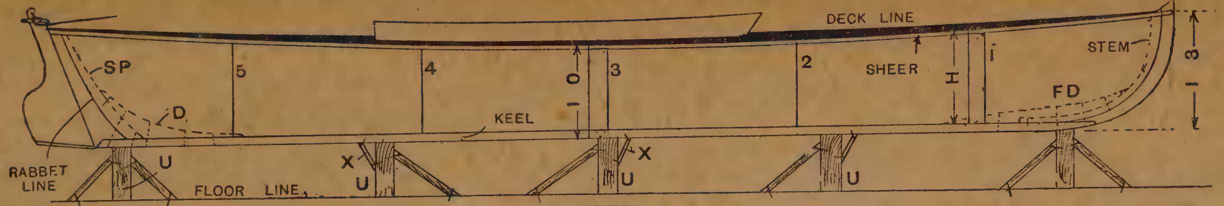


Fig. 13

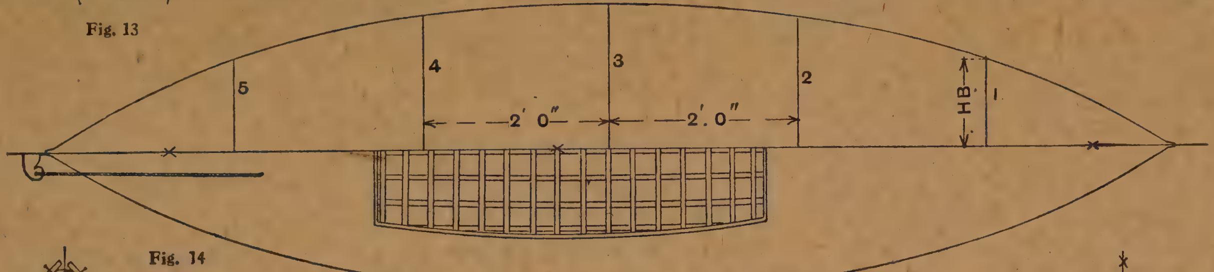


Fig. 14

Figs. 13 and 14.—Sheer Profile and Deck Plan of 12-ft. Canvas Canoe

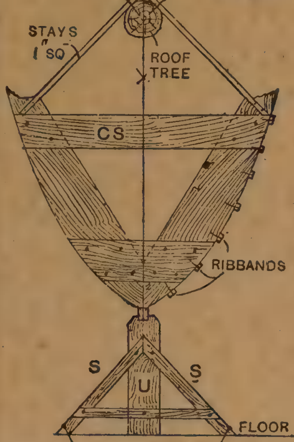


Fig. 16.—Stocks, Roof Tree and Section Mould

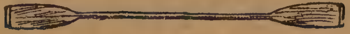


Fig. 19.—Paddle

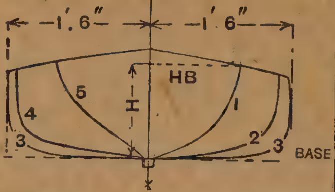


Fig. 17.—Canoe Body Plan

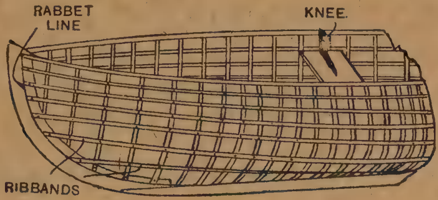


Fig. 15.—Part of Canoe Frame

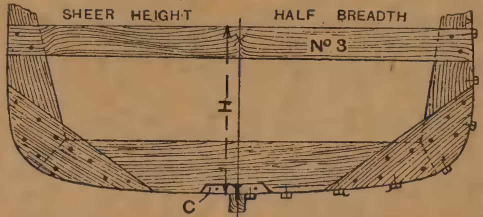


Fig. 18.—Section Mould

Section Moulds.—The keel frame now on the stocks is ready for the section moulds, from which the craft gets its shape. Therefore divide the length of the sheer profile and breadth plan (already laid off on the floor) into six equal parts, which, in the canoe in question, will give a space of 2 ft. between the sections marked 1, 2, 3, 4, and 5 in Figs. 13 and 14. The shape or boundary of these sections must next be drawn in as shown in the body plan (Fig. 17). First strike two vertical lines the width of the boat, 3 ft. apart in this case, and a centre line; also a base line at right angles to these (see Fig. 17). Beginning with section 1, measure on the profile the height H from the top of the keel to the sheer line, and transfer that distance up the centre line, setting off from the base line as shown. Now on the breadth plan (Fig. 14) take the half breadth of section 1 marked H B and transfer it, at right angles to the centre line shown in Fig. 17, at the sheer height already marked. The height and half breadth being marked, line in with thin batten, or even freehand with a piece of chalk, the curved boundary line as shown by section 1 (Fig. 17), and proceed with the other sections in a similar manner, giving a good flat floor as shown.

All the sections, or rather half-sections, being laid off, next make moulds of each one after the style shown by Figs. 16 and 18, of ½-in. spruce. As only the half of each section is laid off, a half-mould is first made to this shape from which the other half is made, and the two strapped together as shown in Fig. 16; a straight stay on top denotes the sheer height, and keeps the mould in shape.

When the section moulds are completed, fix them upright in their respective places with a screw passing through a cleat C (Fig. 18) into the keel; the cleat is about 4 in. long by 1½ in. square, nailed to the moulds. Previous to fixing the moulds in their places, a stout spar or stiff piece of scantling, known as a roof tree, is placed in a fore-and-aft direction over the middle line of the craft and securely fixed to any convenient object. This is to stay the section moulds upright as shown in section in Fig. 16, and also to shore out any unfairness in the ribbands, which will be treated later. It may be added that, when one mould is secured perfectly upright, the others can be taken out of winding by sighting the tops of the cross stays C S.

Ribbands.—The keel frame is now on the stocks with the section moulds in position, ready for the ribbands as shown in Figs. 16 and 18. Cut these out of oak or rock elm a little longer than the boat and about 1 in. wide and $\frac{5}{16}$ in. thick, and plane them, taking the sharp edges off the corners. Now mark the position of the ribbands on each section mould as shown; the ribband shown next to the keel in Fig. 18 is only a short one, about 6 ft. long, placed 'midships, and this is the first one to be fixed to the moulds with 1-in. copper nails. The next ribband up should be shaped on the fore end to fit the stem, and fixed to it with ⅔-in. copper nails (see Fig. 15). Then work along to the other moulds, and tack to them at the places already marked, the after end being cut and shaped to fit the stern post as at the stem. See that the ribband is fair sheerways and between the moulds, and any unfairness may be rectified by easing a little off the moulds, or packing them. In between the moulds a stay from the roof tree or floor would ensure fairness. Proceed in this manner with all the ribbands, keeping the top one level with the sheer heights on the moulds, thus forming the sheer gunwale (see Figs. 16 and 18).

Timbers or Ribs.—The ribbands all on, the timbers or ribs are next taken in hand, and these should be wrought out of rock elm ⅝ in. wide and ⅛ in. thick, and spaced about 5 in. apart. Before bending, immerse the ribs in water for a few hours to soften the fibre, and then bend them to the ribbands, putting a ¾-in. copper nail through the ribband and rib from the outside, after first boring a small hole through both. The nails should be clinched on rooves, and a nail driven into the keel at the timber feet (see Fig. 20). At the extreme ends of the craft, half timbers, known as cants, are bent in and nailed to the stem and deadwoods (see Fig. 15). The timbers all being in and clinched up, fix in the thwarts or cross seats, about 5 in. down (the lower the safer) from the gunwale, making them about 6 in. wide, and fit an oak knee about ½ in. thick at each end. Figs. 13 and 14 show a decked canoe, but this, of course, is a matter of choice.

The thwarts and knees being secured, the temporary section moulds are taken out of the boat; the copper nails driven into them through the ribbands can be drawn or cut away, and the boat or frame will appear like Fig. 15, and ready for putting on the canvas.

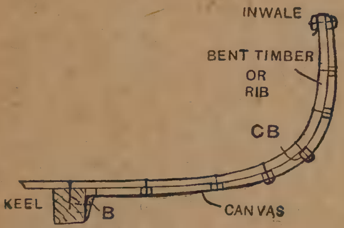


Fig. 20.—Half Section of Canoe

Attaching the Canvas.—For putting on the canvas, release all the fastenings from the stocks, turn the boat bottom up, and secure firmly in a workable position. Obtain some stout canvas of good texture to reach the full length of the craft, and of sufficient width to reach from the keel to the gunwale. Temporarily tack one edge to the side of the keel with ½ in. copper tacks about 6 in. apart, and strike the canvas over the ribbands so that it lays well; should it bunch up or pucker, it may be gathered and neatly tucked back and sewn to the main body of the canvas. Having got the canvas to lay well, nail it to the keel with closely spaced ⅝-in. copper nails, and stretch the canvas over the top ribband or gunwale. Another ribband or inwale is then fixed inside and through-fastened as in Fig. 20, which shows the canvas over the ribbands and gunwale. Where the canvas is not sufficiently wide enough to reach over the gunwale, it should be pieced along one of the ribbands, so that the sewn lap 1 in. wide will lay over a ribband.

At the ends of the boat, cut the canvas to the outer curve of the stem, that is, the face, and turn the edge back or double it till it reaches the rabbet line (see Fig. 15). It may then be nailed up the stem, or, otherwise, a shallow rabbet cut in the stem to receive the doubled thickness of the canvas till it is flush with the stem. Along the keel at each side a wedge-shaped batten B (Fig. 20), ¾ in. wide and ¼ in. thick, is nailed over the canvas as additional security.

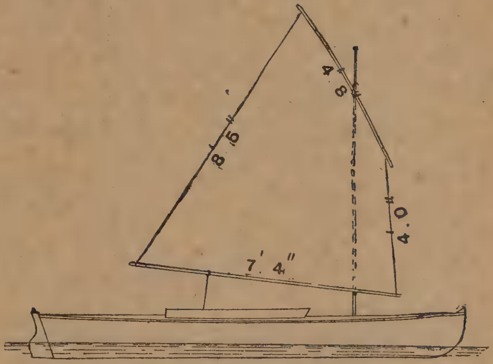


Fig. 21.—Canoe Sail Plan

The canvas being on, chafing battens C B, ⅜ in. thick and 1 in. wide, should be fixed on the outside of the canvas on to the ribbands, particularly at the bilge and gunwale.

Paddles, Sails, etc.—A paddle of spruce (Fig. 19) should be about 7 ft. long, with blades 1 ft. 6 in. long and 6 in. wide. A balance lugsail is shown with dimensions at Fig. 21. The mast is 7 ft. 6 in. above the deck, and 2 in. in diameter.

The completed craft should be coated all over with boiled linseed oil, and when dry, three or four coats of white-lead paint should be given.

It may be mentioned that where difficulty is experienced in obtaining locally the timber previously mentioned, larch and ash may be substituted, while English elm can be made to answer for the knees and breasthooks.

A 9-FT. COLLAPSIBLE CANOE

A suitable material for the canoe illustrated by Fig. 22 is elm or American oak, straight in the grain, solid, and free from knots. It is none the better for being too well seasoned, as it will bend better and be tougher if not too long cut. The over-all length of the canoe is 9 ft.; the keel will therefore be 9 ft. by 1 in. by 1 in. The stem and stern posts are each 1 ft. by 2 in. by 1 in. They are mortised vertically into the ends of the keel, as shown in Fig. 23, the tenon being $1\frac{1}{4}$ in. by $\frac{3}{8}$ in., leaving a rebate of $\frac{3}{4}$ in. on the outside. Give them a good coat of copal varnish after fitting, and dip them and the wedges into varnish when finally putting together.

The junctions of stem and stern posts are further strengthened by means of struts F of $\frac{3}{8}$-in. brass tube, the ends being flattened and bent to form palms, which are screwed to the post and keel K, as shown in Fig. 23.

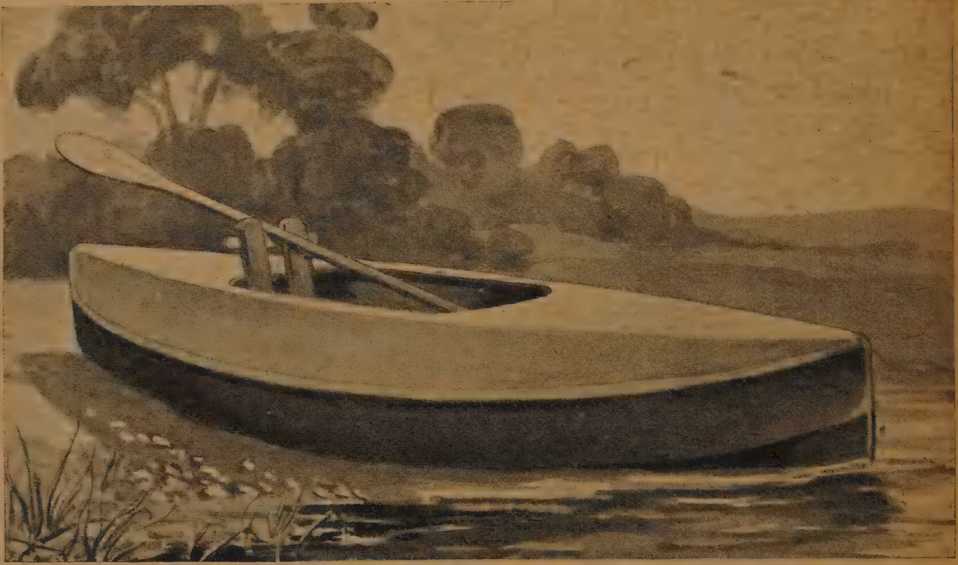


Fig. 22.—Collapsible Canoe in Use

Ribs.—The ribs A, B, and C are round in section, 1 in. in diameter at the middle, tapering to $\frac{5}{8}$ in. in diameter at each end. After the exact length is found, each end is fitted with a brass ferrule H (Fig. 25), to prevent splitting when putting in the screw which forms the pivot on which the rib turns in the brass plate at each end. The curves of the ribs are shown in Fig. 26. They can either be bent with dry heat or steamed in a steaming box. In any case, they must be well heated through and through, or they will have a tendency to straighten, and it is advisable to bend them to a slightly quicker curve than is required, to allow for coming back a little when cool. The curves should be drawn on a wood floor by means of a thin batten and a few large nails driven into the floor, to bend the ribs round, and to keep them in place until cool. The curves can be got from the table of off-sets given at the foot of the next column. In Fig. 26, W represents the bow and S the stern.

In order to ascertain the exact lengths, and to keep the ribs in position until the stretchers are made and fitted, a mould

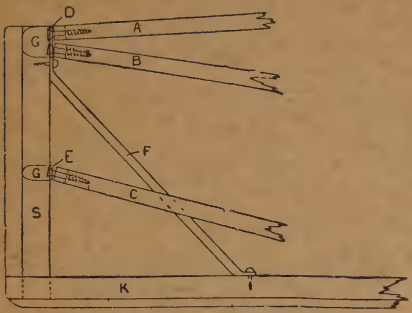


Fig. 23.—Side View of Stern Post, etc.

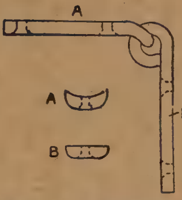


Fig. 29.—Details of Fish-box Hinge

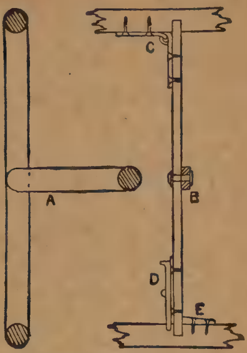


Fig. 28.—Hinged Stretcher, Strut, etc.

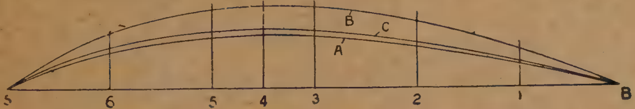


Fig. 26.—Plan of Actual Curves of Ribs

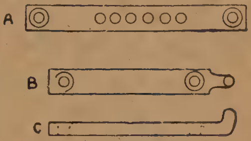


Fig. 34.—Plates for Floor Stretchers

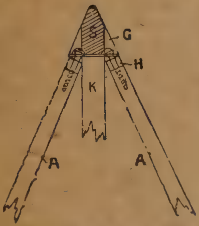


Fig. 25.—Plan of Stern

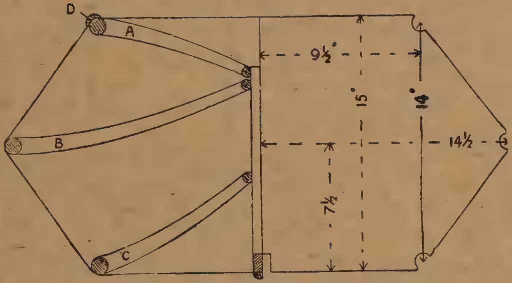


Fig. 27.—'Midships Section

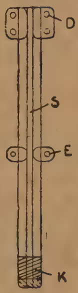


Fig. 24. —Front View of Stern

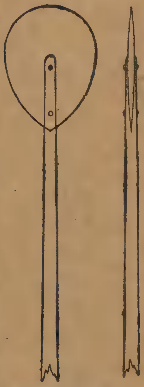


Fig. 33.—Paddle Blade Riveted to Shaft

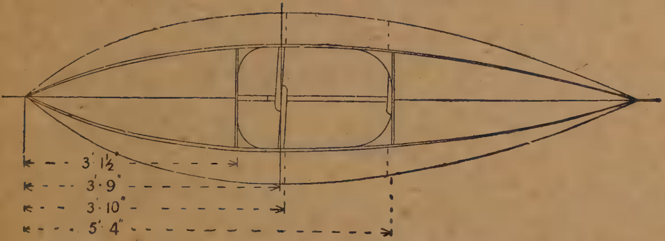


Fig. 30.—Plan of Framework, showing Floor Stretchers in Position

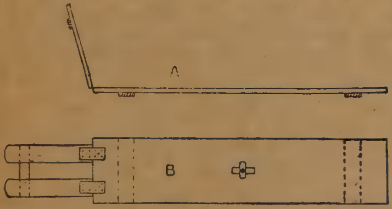


Fig. 32.—Floorboard with Hinged Back

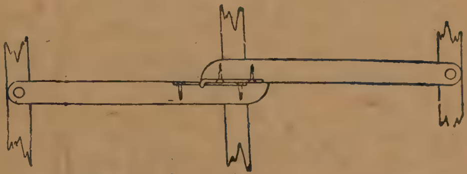


Fig. 31.—Detail of Floor Stretchers

like Fig. 27 will be required. It can be made from $\frac{5}{8}$-in. pine, and is temporarily fixed to the keel just forward of the position of the after stretcher by means of a small steel bracket. It will be advisable to use short screws, so as not to weaken the keel.

When the exact length of each rib on one side has been found by trying it in its place on the mould and marking it, the corresponding rib for the other side must be made exactly the same length. The ribs are fixed by means of a strong brass screw through the brass plates at stem and stern, leaving sufficient play to allow the ribs to fold down alongside of the keel. The plates are made of hard rolled sheet-brass of No. 14 B.W.G. If only ordinary sheet-brass can be obtained, it should be got a gauge heavier and hammered well to stiffen it. The top plates D (Figs. 23 and 24) measure 2$\frac{1}{8}$ in. by 1$\frac{3}{8}$ in. The holes for rib screws are countersunk on the front, and the holes for screwing to stem are countersunk on the back.

Bottom Plates.—The bottom plates E (Figs. 23 and 24) measure 2$\frac{1}{8}$ in. by $\frac{5}{8}$ in. After the plates are fixed, small angled pieces of wood G (Figs. 23 and 25) are fitted to the taper of the stem- and stern-posts, to prevent the edges of the plates from cutting the canvas. They are hollowed out a little on the side next to the plates, to give clearance for the screw-heads to turn.

Stretchers, etc.—The stretchers are next taken in hand. They may be of any kind of hardwood, but elm is the best owing to its toughness. They measure 1 in. by $\frac{5}{16}$ in., and are shaped as shown in Fig. 28. The ends are hollowed out to fit the ribs, to which they are fixed at the top with hinges such as are used for the lids of fish boxes. If these hinges cannot be bought small enough for the purpose, a smith must be got to make half a dozen of them, as shown in Fig. 29. The top tails A must be hollowed to fit the circular section of the rib. The bottom tails B are flat. The tails of the hinges should be 2$\frac{1}{2}$ in. long, made from mild steel $\frac{5}{8}$ in. by $\frac{3}{16}$ in. in section. The hinges should be filed smooth all round, and galvanised or tinned to keep them from rusting. The bottom end of the vertical strut comes against a small cleat screwed on the rib, and is kept in position by a 3-in. brass slip bolt, such as is used on blind frames, which shoots into a hole bored in the rib to receive it. The mid-rib strut A (Fig. 28) is secured to the vertical strut by means of a copper rivet and washer. In Fig. 28, B represents the end view of the strut, C the fish-box hinge fastening the strut to the top rib, D the brass slip bolt into the bottom rib, and E the cleat nailed on the bottom rib behind the strut.

TABLE OF OFF-SETS

Stations	1	2	3	4	5	6
	in.	*in.*	*in.*	*in.*	*in.*	*in.*
Rib A ..	3$\frac{3}{4}$	7	8$\frac{7}{8}$	9$\frac{1}{4}$	8$\frac{3}{4}$	6$\frac{1}{4}$
Rib B ..	6$\frac{1}{2}$	11$\frac{1}{2}$	14$\frac{1}{8}$	14$\frac{1}{2}$	14	9$\frac{5}{8}$
Rib C ..	4$\frac{1}{4}$	7$\frac{3}{4}$	9$\frac{3}{4}$	10$\frac{1}{4}$	9$\frac{5}{8}$	7

The deck expanders measure 1 in. by $\frac{1}{2}$ in., and are hinged to the rib at one end, and fitted with cleat and slip bolt at the other. The position of the deck expanders will be seen in Fig. 30, which is a plan of the canoe before the canvas is fixed. The floor stretchers are also seen in Fig. 30, and in detail in Fig. 31. They are fixed to the bottom ribs at one end, so as to turn round when folded up, on a copper rivet through the rib. The other end of A (Fig. 28) is fitted with a brass plate, shown in Fig. 34, which has a bent rounded part at one end fitting easily into the holes in the plate on the edge of the other stretcher. These plates are shown in detail by Fig. 34. Plate A is 3$\frac{1}{4}$ in. by $\frac{5}{16}$ in. by $\frac{1}{8}$ in. thick; plate B, also shown in side view at C, is 2$\frac{3}{4}$ in. long, same breadth and thickness as the other. Two plates of each will be required.

In expanding the boat, the floor stretchers are last fixed, and by trying the pin in one hole after another, the proper hole will be found, which will give the skin the requisite amount of tension.

The floor stretchers are kept in position by the bottom board, shown in

Fig. 32, which has fillets across it in such a position that they will fit in between the floor stretchers and keep them in position. The bottom board is in its turn kept in position by means of a turn-button secured on a block in the centre of the keel, which comes through a slot in the bottom board, and is then turned square across. The bottom board being kept up at the ends by the bottom stretchers, has to be pressed down in the middle to allow the button to turn, which puts sufficient spring into it to keep everything securely in position.

The back board is hinged to the after end of the bottom board with leather hinges, fixed with copper tacks clinched on the other side. It should be in two pieces, leaving a space in the middle to ease the backbone of the one-man crew. It is shown in elevation (A) and plan (B) in Fig. 32.

When this stage is reached the whole framework should receive three coats of good copal varnish. When thoroughly dry the canvas covering is taken in hand.

The Canvas Covering.—The canvas is the kind used for tarpaulin covers, and should be made of hemp. It may weigh anything between 12 oz. and 18 oz. per yard, and should be obtained 3 ft. 2 in. wide if possible. About 7 yds. will be required. If it cannot be obtained quite this width, it may be stretched for about 2 in. in the middle of one of the pieces by tacking it along one edge to a board. It is then stretched tightly across and tacked down at the other edge. If it is now thoroughly wetted it will be found almost 2 in. wider when dry. If not then wide enough, the process may be repeated. The canvas for the deck will not require stretching, as a cut may be made along the centre of the well hole, which will enable it to give sufficiently to meet the side ribs without undue strain. It should all be thoroughly soaked and rinsed to remove the batter, and dried before fitting. One piece will reach from the middle rib on each side round the keel, forming the floor and the bottoms of the sides. The other piece will stretch from the same ribs over the top forming the deck and top sides. It is fixed to the framing with ½ in. copper tacks.

With the frame upside down, place the centre of the canvas along the keel and tack every 2 in. Then tack to the side ribs, beginning 'midships and tacking alternately forward and aft, stretching just tight enough to avoid wrinkles. Do not continue the tacking quite to the ends of the centre ribs, or it will not fold up, but leave about 18 in. at each end to be afterwards dealt with. Proceed in the same manner with the deck, leaving the well hole to be cut later. The ends must now be tacked to the forward edge of the stem and to the stern post, the one side overlapping the other. A strip of elm or oak, 1 in. by ½ in., is now fitted along the keel, covering the tacks, and a strip of thin sheet-brass or copper fixed up the edges of stem and stern post, bending round on to the keel for 2 in. or 3 in.

The places at each end where the canvas has been left untacked are now cut sufficiently full to allow them to meet when the edges are turned in for ½ in. They are then sewn together with a bent needle and strong waxed thread, making the stitches very close and firm. The well can now be cut out with a sharp knife, leaving a margin of ½ in. all round to turn in for a hem.

If the expanders are now taken down, the canoe should fold up quite closely without straining in any place. If all is correct it should be expanded again, and half-round strips D (Fig. 27) fitted on the centre ribs to protect the canvas from rubbing and to cover the tacks. The strips on the centre ribs should extend to the beginning of the sewn part at each end. There are also strips put on the upper ribs at each side of the well, extending the length of the well. Note that the canvas is only tacked to the upper rib for the length of the well.

Before fixing the covering strips the whole canoe should receive two or three coats of paint made as follows : Boil 3 oz. of hard yellow soap in 1 pt. of water ; while hot add 2½ lb. yellow ochre (or other colour) ground in oil, 1 oz. terebine, and 3 pt. boiled linseed oil. Stir thoroughly, and when cold apply with a brush like ordinary paint. Special care should be taken with the first coat to see that it is well rubbed into the canvas, which will take in a good deal at first. This paint will dry fairly quickly, but will never get so hard as to crack with the folding. Each succeeding coat will, of course, take a little longer to dry; but if put in a dry, airy place, the fourth coat should dry in a week, and should give a perfectly waterproof skin. The protective strips should be fixed with thin brass screws after the second coat.

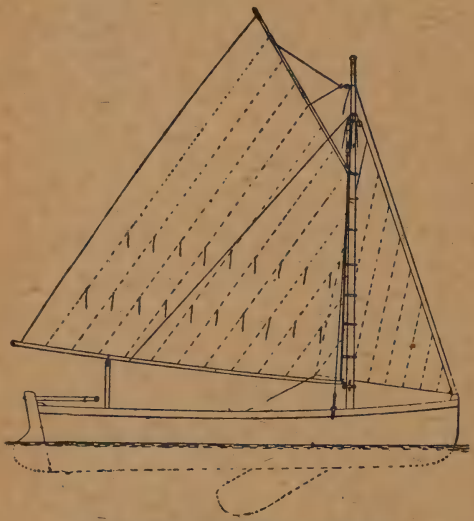


Fig. 35.—Sail Plan of Boat

Paddle, etc.— For convenience of packing, the paddle is better made in two and spliced in the middle of the handle. This may be done either by means of a light brass ferrule, or simply an angled splice about 6 in. long tied with twine. A dowel pin in the centre is a convenience as it prevents the splice splitting. To save material and work, the paddle blades may be made separately and riveted on to the shaft, as shown in Fig. 33. A rubber ring slipped on to the shaft at each end between the blade and the hands will stop most of the water from running and wetting the hands while paddling.

A waterproof apron may be made to cover in the well, but should not be fixed to it, in case of an upset. A better plan is to fit the apron to a belt which goes round the waist, making it large enough to lie along the deck and down the sides.

AN OPEN KNOCKABOUT SAILING BOAT

The design illustrated by Figs. 35 to 39 is for an open knockabout boat with a moderate sail area and fitted with a drop keel, suitable for estuary or fairly open waters; it should also behave well in a seaway. It is 18 ft. over all by 5 ft. 9 in. beam by 2 ft. 2½ in. moulded depth 'midships. The approximate weight of the hull, including drop plate, spars, gear, etc., is 6 cwt., and the displacement to the load water-line (L.W.L.) is 15·25 cwt. The mean moulded draught is 10½ in., the draught aft to the bottom of the keel is 1 ft. 3 in., and the extreme draught with the centre plate all down is 3 ft., which can gradually be reduced, as the handle bar (see Fig. 36) is provided with pin holes 3½ in. apart. The sail plan (Fig. 35) shows a spread of 155 sq. ft. With a crew of two, about 2 cwt. of ballast would be beneficial. Sand bags are useful, as they can be emptied when passengers are taken aboard.

To build, it is usual to lay off the sheer profile (Fig. 36) and body plan (Fig. 38) full size, filling in all details; then work to this, making thin moulds of the stem, stern post, deadwoods, centre-board trunk, etc. These moulds are then applied to the timber, lined off and sawn, with little fitting. The keel is of Canada rock elm and is 3 in. deep throughout.

The rebate line is parallel to the bottom of the keel 2 in. up, and the inbreast or keel apron is wrought in it (see Fig. 38). The full width 'midships is 5½ in., tapering at each end to suit the stem and stern post, and leaving sufficient back rebate. The width of the bottom is 4 in., tapering to the face of the stern post and stem. The slot in the keel is ⅞ in. wide, and the shaped stem is of crooked oak 2¼ in. thick. The stern post is 2¼ in. thick, moulded 6½ in. at the keel and 3 in. at the head.

The deadwoods are 2½ in. thick, moulded

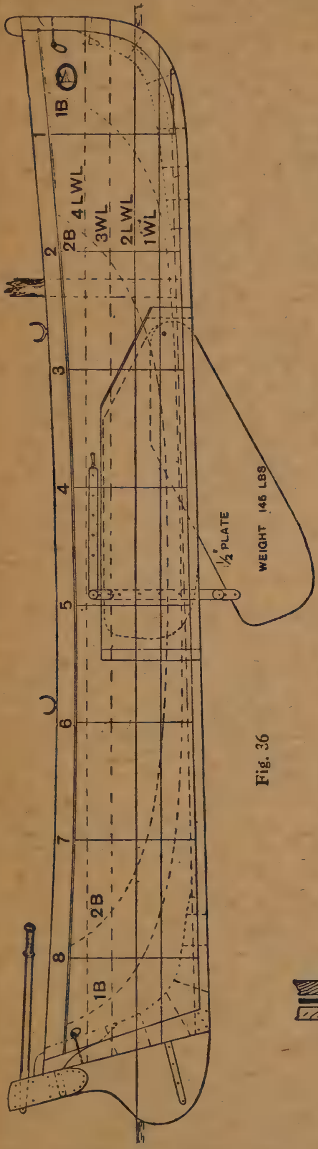


Fig. 36

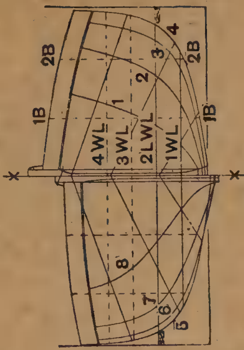


Fig. 38

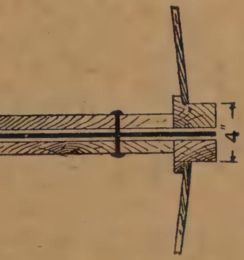


Fig. 39

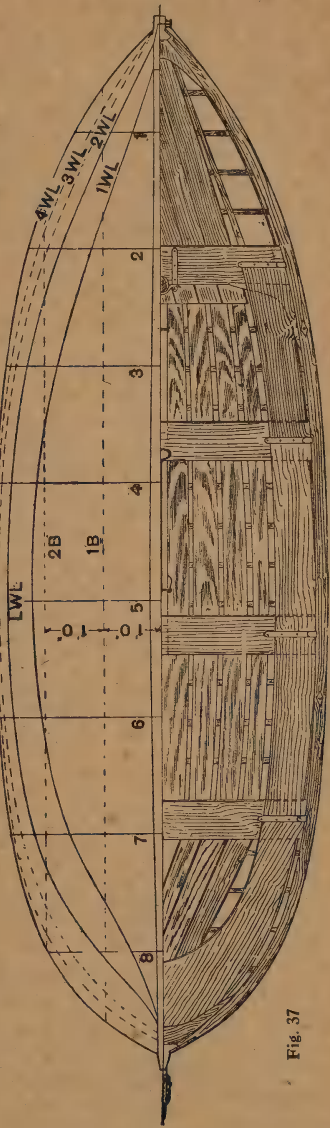


Fig. 37

Figs. 36 and 37.—Sheer Profile and Two Half-plans of Sailing Boat

Fig. 38.—Body Plan

Fig. 39.—Centre-board Fitting

as shown in Fig. 36, and are through bolted with $\frac{5}{16}$-in. galvanised iron bolts clinched on rings. The aprons, 4 in. by 2¼ in., receive the upper planking.

The body plan being laid off full size, the moulds are made of each section out of ½-in. spruce, and are fixed in place, this giving a guide for the rebating. Next the planking is proceeded with, after the section moulds are horned true and stayed. The sizes given include the plank, which must be deducted when laying off. The planking, of good larch not overgrown, is ½ in. thick, and lap-strake or clincher built, having eleven strakes of plank at each side with a lap or landing of

⅞ in. It is usual in good practice to have the bilge planks a little narrower than the others, as the bent timbers lie better to them, besides being stronger. The timbers of rock elm, 1¼ in. by ¾ in., steamed and bent to shape, are through clinch fastened at every landing, and are spaced at 8 in. centres, with two clinched nails between them.

The gunwales of rock elm are 2 in. deep throughout and 2 in. wide 'midships, tapering to about 1½ in. at each end ; they are steamed and bent to shape.

The thwarts are of 1-in. pitch pine, 8 in. wide, and in the wake of the centre-board trunk are chocked underneath and screwed into the sides of the trunk.

The risings which carry the thwarts are 9 in. down from the gunwales, and are of larch 2½ in. by ¾ in., through fastened at each timber. There are two grown oak knees to each thwart 1¼ in. thick, about 1 ft. on the foot and 3¼ in. at the head, while the mast thwart is additionally strengthened with a rider knee (see Fig. 37). The breast hooks of crooked oak at each end are 2 in. thick, and are through bolted at the throat and gunwales with ⅜-in. galvanised iron bolts clinched.

The side seats of yellow pine are 10 in. wide and ⅞ in. thick. The centre-plate trunk is of 1-in. yellow pine fitting into a rebate well luted with white lead.

The rudder is of oak 1⅛ in. thick, and is hung on a ⅝-in. galvanised iron rod, and ships from the top. The cheeks are ⅝-in. thick and clinch fastened through the rudder head, forming the tiller aperture. The elm tiller, 2 in. by 1⅛ in., is 3 ft. long, and is straight.

The flooring boards are skeleton framed, as shown by Fig. 37, and are of ½-in. larch, clinched on bent battens 2½ in. wide by ½ in. thick. The sheets at each end are of ½-in. spruce. The centre plate or drop keel is of ½ in. boiler plate, and weighs about 145 lb. The handle bar is 2 in. wide and ½ in. thick, the pin of the plate being ½ in. in diameter, its centre being 5 ft. 5 in. from the face of the stem, and 6 in. from the bottom of the keel. The radius of the plate is 5ft. 2½ in., and the width 1 ft. 7 in.

The spars should be best Christiania spars, as near grown size as possible. The mast from the gunwale to the hounds is 12 ft. 6 in., with a spire of 2 ft. 6 in. It is 3½ in. in diameter at the clamp, and 2½ in. at the hounds, and fits in a 2-in. oak step on the top of the keel, butting against the trunk. A wire shroud is fitted at each side. The boom is 14 ft. 3 in. over all, 2¾ in. in diameter at about one third from the outer end, and 2 in. in diameter at each end, fitting into a spider band on the mast. The gaff is 8 ft. long and 1¾ in. in diameter, fitted with neat oak jaws, the peak halliards hooking on to a wire span. The truck of teak is 2¾ in. in diameter and 1¼ in. thick, with two holes for signal halliards. A channel plate for the lanyards of the shroud is clinched on to a timber. Two rowlock holes at each side will be useful, and a ring bolt at each end (see Fig. 36) for mooring, etc.

Two elm bilge pieces at each side, 8 ft. by 1¼ in. by ¾ in., will protect the boat. Oars about 12 ft. long should suit this craft.

	Stem	1	2	3	4	5	6	7	8	Stern Post
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
Sheer heights above L.W.L.	1 11½	1 9	1 7	1 5½	1 4½	1 4	1 4⅛	1 4⅝	1 5⅜	1 7
L.W.L. to rebate line ..		8⅜	9¼	9⅞	10½	11	11½	1 0⅛	1 0¾	
Half breadths at gunwale		1 5½	2 3⅛	2 7⅞	2 9⅞	2 10⅜	2 9½	2 7⅛	1 11½	
Half breaths at 4 W.L. ..		1 2½	2 1	2 7	2 9½	2 10	2 9	2 6½	1 9⅝	
,, ,, 3 W.L. ..		1 0¾	1 11¼	2 5⅞	2 8⅞	2 9½	2 8⅜	2 5	1 6⅞	
,, ,, L.W.L. ..		10	1 8½	2 3⅝	2 7	2 7½	2 6½	2 2⅜	1 1	
,, ,, 1 W.L. ..		6	1 2⅛	1 9½	2 1½	2 2½	2 0⅞	1 7	6½	
From L.W.L. 1 B. ..		3	6½	8	8⅞	9¼	9⅜	7⅞	1	
,, ,, 2 B. ..			6¾	4	5⅞	6¼	5½	2		

Water lines are 5 in. apart, the sections are 2 ft. apart, and the buttock lines are spaced 1 ft.

OPEN SEAMS IN BOATS

After a boat has been hauled out of the water for the winter, the planking is liable to dry up and consequently shrink so much that when the boat is launched at the beginning of the next season considerable leakage takes place, damaging the paintwork and causing much annoyance and labour. This may be avoided by coating the outside of the planking of the underwater portions with raw linseed oil, soon after the boat has been hauled out. This prevents, to a great extent, the evaporation of the moisture present in the wood, and minimises the amount of shrinkage.

It sometimes happens that, from various causes, the planking of a boat skrinks so much that daylight can be seen through the seams. Should the trouble have been caused by the rotting of the caulking material, re-caulking will, of course, be necessary. It may have been the result of using green (or unseasoned) wood for the planking, but the remedy is the same—re-caulking. But, in general, it is desirable to be very careful about re-caulking seams which are open merely as the result of the wood being very dry, as many a boat has been ruined through being caulked so tightly that no room was left for the swelling of the planking, with the result that the planking burst away from, or broke the timbers. In such a case the best thing is to fill the seams with common soap just before launching the boat. This will prevent much water from getting in, but will be squeezed out as the planks swell up again and the edges come together.

Fitting Carpet on Stairs

First measure how many yards of carpet are required. Fix the end of a tape measure on the top stair, about 1 ft. on the landing, by sticking a bradawl through the ring, and then trace the measure over each stair. Allow half a yard or so over so that the tread of the carpet may be changed occasionally.

The rods should generally be at least 4 in. longer than the width of the carpet. To fix the eyes, brass screws or pins should be used, and a space of 1 in. over the width of the carpet must be allowed between them; as it would be tedious to measure for each eye, a piece of cardboard or wood is cut the exact measurement between the corner of the stair and the eye, to be used as a guide. Should the base of the newel post on the first stair prevent the rod being put in with ordinary eyes, use hinged eyes.

Most stair carpet is now made of reversible pattern, so that either end may be put at the top. About 1 ft. of the carpet should be tacked on the top stair; it should then be rolled down one step at a time, the felt stair pads being placed and rods put in whilst proceeding to the bottom stair. In laying carpet on winding stairs, the carpet should not be cut, it being better to double it and tack to the front side of the stairs.

When a carpet has to be fitted to a flight of stone steps the eyes have to be fixed by drilling the stone with a Rawlplug tool started lightly in the ordinary way, finishing, if necessary, by inserting the tool in a brace and drilling. The Rawlplug—the jute sleeve or tube—itself is then slipped in and the screw inserted.

Making Induction Coils

What an Induction Coil Is.—The induction coil has been simply defined as "a device for producing high-tension electricity from low-tension electricity, such as is supplied by primary batteries or accumulators. This conversion is the result of a well-known electro magnetic phenomenon, in which electricity is automatically induced in one coil of wire by the current flowing in another coil adjacent, but not connected to it. The tension of the induced electricity is higher or lower than that in the primary circuit, according as the secondary coil in which it is generated has more or fewer turns than the other. Other things being equal, the ratio of these two voltages is directly proportional to the ratio of the number of turns in the respective windings. In order to get the best effect, the coils are wound concentric with one another—the secondary, or high tension, winding being placed on the outside—and the magnetic core, around which they are wound, is built up of soft iron wires. A comparatively small quantity of current flows in the secondary circuit, and the high-tension winding can, therefore, be composed of much finer wire than the primary winding, which is connected to the battery, and the wire which is used is, in fact, no thicker than ordinary sewing cotton. The wire of which induction coils are formed is, of course, thoroughly insulated, that forming the secondary winding being covered with silk, and, owing to the difference in voltage, the two windings also have to be very carefully insulated from one another.

Ignition and Wireless Telegraphy Coils.—Medical coils, shocking coils, spark coils, ignition coils, wireless telegraphy coils, etc., are all varieties of the induction coil; sometimes the first two are identical, and the last two are simply varieties of the spark coil. The term "ignition coil" is applied to those small induction coils specially intended for firing the charge in internal-combustion engines (gas, petrol, and oil engines). Moreover, ignition coils are nearly always of the same size, and give from $\frac{1}{4}$-in. to $\frac{1}{2}$-in. spark in air, about $\frac{3}{8}$ in. being the average. Also, they are usually designed to give a "fat" spark; that is, a thick, furry secondary discharge, which is hotter than a thin blue spark, and more reliable for igniting the explosive gases.

An induction coil is really a step-up transformer, consisting of a finely laminated iron core with a few turns of thick wire wound on it forming the primary coil, and over this a great number of turns of very fine wire forming the secondary coil, in which an electro-motive force of very high potential is induced by means of the magnetic flux due to the iron-cored primary. The primary and secondary circuits are quite independent, as has already been shown, and insulated electrically from one another, the action on the secondary being purely inductive; hence the name "induction coil."

Induction coils have been made of considerable size; the writer believes the largest one ever constructed to be an Apps coil, built for the Japanese Government for wireless telegraphy purposes, giving a spark of no less than 48 ins. long. For wireless telegraphy a short spark is of no use at all, the electrical waves set up by such a discharge being too feeble to detect at any but very short distances. Ignition coils, therefore, are useless for wireless telegraphy.

The Connections of a Simple Coil.—The connections in the case, say, of a common shocking coil are very easily understood. There is a coil (the primary coil) of thick wire wound around a core of iron wires; one end of this coil is connected to a small brass pillar, and the other end to the foot of the vibrating spring forming part of the contact breaker; this and the contact screw and its supporting pillar is connected (beneath the coil) to another small brass pillar. These brass pillars are named "terminals," or binding screws, and the two line wires from the battery are connected to these terminals. When thus connected, the vibrating spring will hum like a bee. If now the handles of the conducting cords are also connected to the primary terminals and grasped in two hands, a mild tingling sensation will be felt in the fingers. This is the shock from the primary coil. Over the primary coil is wound a very long thin wire to form the secondary coil, and the two ends of this wire are brought out to two separate terminals. If the handles are connected to these and grasped in the hands, some sharp shocks will be felt, which will increase in severity with an increase of current through the primary.

Medical Coils and Spark Coils.—Induction coils—devices by means of which low-intensity electrical currents are transformed into high-intensity currents—are of many kinds, those in which the amateur is chiefly interested being medical coils, shocking coils, and spark coils. Medical and shocking coils differ from spark coils in only a few respects. The bobbin of the medical and shocking coil is similar to that of a spark coil, with a bundle of soft iron wires for the core; but this core may have an air space between its outer surface and the inner surface of the body of the bobbin, the space being occupied by a brass tube made free to slide over the core and so cover a part or the whole of it. It is not necessary to have a core or a sliding tube over the core, as good results may be obtained without either; but the apparatus is more under the control of the operator when the coil is provided with a core and sliding tube, for the core increases the inductive effect of the current on the wire, and the tube can be so regulated as to absorb a part or all of this in itself.

The primary wire of a medical coil may be thinner and longer than that of a spark coil, because it is not necessary to run a heavy current through it, and because part of its inductive effects may be employed together with or apart from those of the secondary wire.

The secondary wire may be thicker and shorter than the secondary of a spark coil, and it may consist of two, three, or more short coils of wire of different gauges connected together with advantage, since each coil will represent a separate power or unit of the induced current, and these units may then be used separately or combined as required.

The contact breaker may also differ from that of a spark coil, and be an entirely separate part in the apparatus, where there is no iron core.

Another point of difference lies in the absence of a condenser, this not being required in a medical coil. As there are no specified tension effects to be aimed at in the construction of an ordinary medical coil, it is not necessary to calculate previously proportionate measurements of its parts, since a small bobbin filled with wire is as effective as a larger one, and a cotton-covered wire gives as good results as a wire covered with silk. There are circumstances in which it is necessary to make calculations to ensure a definite E.M.F. at the terminals of a medical coil, to overcome resistance in the subject operated on; but the ordinary cheap medical coils are not so constructed.

Making a Medical Coil.—The useful little pocket medical coil shown in sectional elevation and plan by Figs. 1 and 2 may be made as follows: Procure some No. 20 iron wire and cut it into pieces 3 in. long, cutting enough to form a bundle ¼ in. in diameter; bind the bundle tightly with fire iron wire, and put it in a dying fire, leaving it there all night. In the morning, take out the bundle and dip both ends first in weak spirits of salt to get off the red rust, next into killed spirits of salt as prepared for soldering, then into a pool of molten soft solder until the wires at both ends are matted together. The surplus solder should be trimmed off with a coarse file, the binding wire taken off, and the ends filed off flush and smooth. This will form the soft core of the coil A.

Next get a 3-in. length of thin brass tube just large enough to slip easily over the core, solder a small brass knob at one end to serve as a handle, and put the core into the tube B up to within ½ in. of the end. Now coat the brass tube with a single layer of thin greasy paper, and over this glue or paste several layers of thin brown paper to form a stiff body for the coil bobbin. When this is quite firm and stiff, fit on two bobbin ends of hardwood 1 in. in diameter and ⅜ in. in thickness. One of these must exactly fit the iron core, and the other the papered tube.

To ensure the necessary firmness to the end on the iron core, it is advisable to solder on that end a brass ferrule thick enough to bring its diameter up to the diameter of the paper tube. The ends must then be firmly fixed to the tube with hot, strong glue.

When the bobbin has become firm enough, the primary wire C should be wound on it. This may be four layers of No. 22 silk- or cotton-covered copper wire. Pierce a small hole in the back end of the bobbin, close down to the tube, and put one end of the primary wire through it to the length of 6 in.; then coil this free end round a pencil to form a spiral, and wind on the first layer, basting it with melted paraffin wax. Then wind another layer, and so on, basting each layer with the molten wax. Bring 6 in. of the end of the last layer out through another hole in the same bobbin end, and make this into a spiral as before.

Next get a ¼ lb. of No. 36 silk-covered copper wire, and wind this over the primary to form the secondary coil D, treating this in the same way as the primary; but be sure to wind each turn side by side as smoothly as a reel of cotton is wound, and avoid making snarls, kinks, and knots.

The two free ends of the secondary wire may now be connected to the two binding screws E (see Fig. 2) inserted in the base as shown. In adopting a vertical form of medical coil for carrying in a small box, the binding screws are fitted in the bobbin ends, as shown in Fig. 3, which is an end view. Another binding screw F (Fig. 1) will be needed for one of the free ends of the primary; the other free end will be connected to the foot of the rheotome spring H, and then through G to the bindings crew F (Fig. 2).

To connect the contact piece of the rheotome with the battery, it will be necessary to have two binding screws F (Fig. 2) as terminals to the primary as well as to the secondary wire. The best binding screws for the purpose are those of the telegraph pattern, as these grip a good surface of wire and make a secure connection.

The rheotome of a medical coil is the little apparatus that interrupts the current from the battery to the coil, and thus causes it to assume a jerky flow through the wire. This is necessary to produce inductive effects in the secondary wire and the high tension current required from the coil. Unless the flow of current through the primary is thus interrupted, there will be no current from the secondary coil. This interruption of the current is performed automatically by the rheotome, which is constructed in the following manner: A disc of soft iron K (Fig. 5), ⅜ in. in diameter and ¼ in. thick, is soldered to the middle of a thin strip of hard german silver or brass 1 in. long and ⅜ in. wide. The two free ends should be flexible enough to form springs. A $\frac{3}{16}$-in. hole must be drilled close to one end of the strip, and a $\frac{1}{16}$-in. by $\frac{3}{8}$-in. slot cut at the other end (see Fig. 4). The hole will serve to hold the spring to a small binding screw on one side of the core, and the slot will be held by another binding screw on the opposite side of the core, thus holding the soft iron disc close down over the centre of the iron core of the coil. A speck of platinum foil must now be soldered to the brass strip at the back, over the centre of the iron disc (see Fig. 4), to form an incorrodible contact spot to a platinum-tipped screw. This screw will be held in a suitable bridge of brass L (see also Fig. 6) that spans transversely the rheotome spring (see Fig. 3, where M is the rheotome spring). If all is constructed and adjusted properly, the core will be magnetised by the current passing through the primary coil, and will then attract the iron disc of the rheotome, pulling it away from the contact screw N (Fig. 5) and interrupting the current. When the current is thus interrupted, the core will become demagnetised and lose its hold on the iron disc K, which will then fly back in contact again with the screw. This will be done rapidly, and produce the required shocks from the secondary coil.

The foot of the bridge that holds the contact screw must be connected to a binding screw by a short length of No. 22 copper wire, and to this screw one wire from the battery will be connected, whilst the other is connected to the other screw in connection with one end of the primary coil. This coil can be easily worked with one or two half-pint bichromate cells.

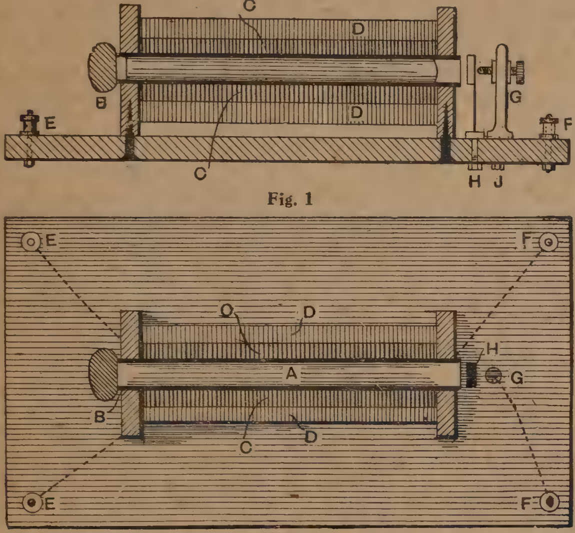


Fig. 1

Fig. 2

Figs. 1 and 2.—Sectional Elevation and Plan of Pocket Medical Coil

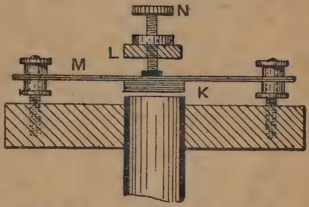


Fig. 5.—Section Through Rheotome

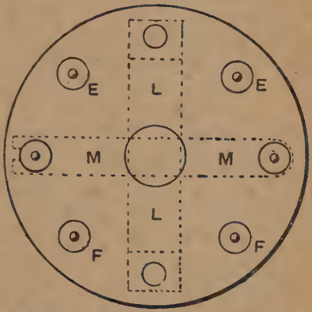


Fig. 3.—Plan of Connecting Screws and Rheotome

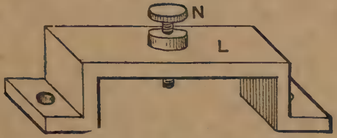


Fig. 6.—Bridge and Contact Screw

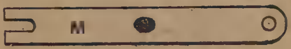


Fig. 4.—Rheotome Spring

Making Larger Medical Coils.—If the constructive principles already given are followed in making larger coils, the diameter and length of the bobbin, the diameter and length of the core, and the gauge and length of wire should be proportionately increased until the shocks given by the induced current of the secondary coil are too strong to be borne. The diameter of the core may be increased by $\frac{1}{8}$ in. to $\frac{3}{4}$ in., and the length by $\frac{1}{2}$ in. to 5 in.; the diameter of the bobbin may be increased by $\frac{1}{2}$ in. to 3 in. It is not advisable, however, to increase the gauge or number of layers of the primary coil, or to reduce the gauge of the secondary coil, since No. 36 wire will be quite fine enough. On the other hand, it will be an advantage to use a coarse gauge for the secondary coil, as its weight and length is increased in the larger sizes. It is not advisable to use more than $\frac{1}{2}$ lb. of No. 36 wire as the secondary of a medical coil; but as this would make a long coil look thin, a more bulky and apparently stronger coil could be constructed by using a coarser gauge, with equally good results as regards power. Half a pound of No. 36 silk-covered wire will run to 825 yd. To get the same, or nearly the same length of wire in a larger gauge, 13 oz. of No. 34, 18 oz. of No. 32, $1\frac{1}{2}$ lb. of No. 30, or 2 lb. 2 oz. of No. 28 may be used.

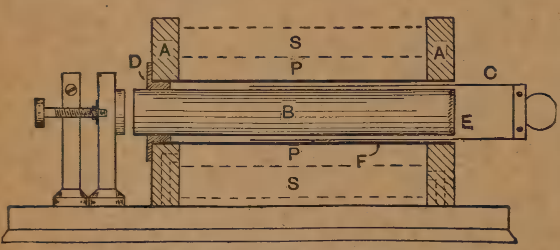


Fig. 7.—Vertical Section Through a Larger Medical Coil

In making larger coils, where compactness is not particularly desired, the horizontal position is usually adopted and the coil secured to a heavy baseboard of hardwood, nicely polished. In this form the free ends of the wires are conducted by secret passages to the under side of the base, and there secured to the tangs of the binding screws, which appear above the base to form the terminals of the coil. Space is also provided on this base for a larger rheotome worked like that of a spark coil when there is a core to the coil, or for a separate rheotome when there is no core in the coil, or when so constructed as to make its action by the magnetised core impracticable. A simply constructed but effective rheotome may be made by providing a small electro-magnet of straight or horseshoe shape, wound with two layers of No. 22 gauge wire (included in the primary circuit) to work the break spring of the apparatus. As the intensity of the shock from a medical coil is greatly affected by the pulsations of the rheotome, the shocks may be regulated by these pulsations. Long pulsations give sharp, jerky shocks, without any good results. Short pulsations are far more beneficial, and these may be secured by so adjusting the contact screw of the rheotome as to allow but very little play between the tip of the screw and the contact spot on the spring.

Amateurs sometimes ask for particulars of combined medical and spark coils, but such coils would not give satisfaction, and the better course is to make two separate coils.

In Fig. 7, which is a sectional view of a medical coil, with a core $1\frac{5}{8}$ in. longer than that already described, the coil cheeks A are 2 in. in diameter, and of $\frac{3}{8}$-in. ebonite or hardwood, polished. The core B is of No. 22 charcoal iron wire, $4\frac{5}{8}$ in. long and $\frac{1}{2}$ in. in diameter; C is the thin brass tube sliding over the core. First turn up a brass flanged ring D of slightly less internal diameter than the brass tube C, and fill with the iron wires. Bind the other end of the core with wire; solder the ends together for $\frac{1}{4}$ in. (see E). Then remove the binding wire and clean up. The brass tube C should slide easily over the core. Make a paper tube F of three or four thicknesses of stout drawing paper, using glue. Drill a hole in each coil cheek A to receive the paper tube F. Space the cheeks $3\frac{3}{4}$ in. apart, and secure to the tube with glue. Fit the core, screwing the brass flange to the bobbin cheek. For the primary, put on four or six layers of No. 20 S.W.G. silk-covered copper wire. Baste with hot paraffin wax, and cover with two or three layers of notepaper. For the secondary, put on twenty layers of No. 36 or No. 38 S.W.G. silk-covered copper wire. The ends of the primary and secondary windings may be passed through holes drilled in the coil cheeks, as shown by the dotted lines.

Fig. 8 shows the connections. The primary and secondary windings are both laid on in the same direction. The outer end of the primary is joined to the inner end of the secondary, both windings being then in series. The ends are also connected to the terminal P S. The electrodes may be connected as follows: P and P S, primary, weakest; S and P S, secondary, stronger; P and S, combined primary and secondary, strongest. In each case the strength of the shock is regulated by sliding the brass tube C in or out. The battery of two or three cells is joined to the terminals B.

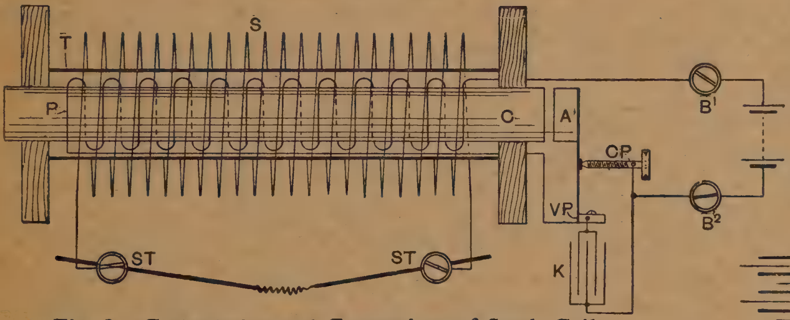


Fig. 9.—Construction and Connections of Spark Coil

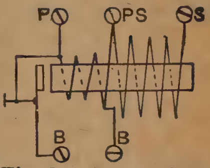


Fig. 8.—Connections of Medical Coil

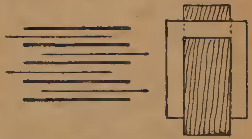


Fig. 10.—Details of Condenser

Spark Coils.—Fig. 9 shows the connections of a spark coil, the dimensions for coils of $\frac{1}{2}$ in. and 1 in. sparks being given later. The core C consists of a bundle of No. 22 B.W.G. charcoal iron wire, over which is laid two thicknesses of stout paper, coated with shellac varnish. The current in the primary P makes the core C an electro-magnet, the strength of the electro-magnet depending mainly on the number of ampere-turns of the primary. Increasing the number of turns of the primary increases the self-induction of the coil, which in effect retards the rise and fall of the primary current, delaying the magnetisation and demagnetisation of the core. Practice shows that for the primary coil, two, or not more than three layers of thick copper wire, silk covered, with a fairly large current, give the best results. T is a tube of insulating material between the primary and secondary coils. The tube may be of ebonite, glass, or may be made of stout drawing paper, to a thickness of about $\frac{3}{32}$ in. for a 1-in. spark. The paper tube should be well coated with shellac varnish. The secondary coil S is of small gauge copper wire, silk covered. The linear length of each layer of the secondary should be at least $\frac{1}{2}$ in. less than that of the primary.

Sometimes the secondary is built up in sections, but for sparks of 1 in. or less, the advantage of sectional winding is doubtful. Between each layer of the secondary and primary windings should be placed a single sheet of paraffined notepaper.

In winding, the wire should pass through a bath of hot paraffin wax, the surplus wax being wiped off with a piece of old linen whilst the wire is being fed on to the bobbin. When the secondary winding is completed, the coil should be well basted with hot paraffin wax and then covered with several thicknesses of paper, the outer covering to be of leather or cloth.

The ends of the secondary are joined to the spark terminals S T, which are fitted with sliding rods having insulated handles. One end of the primary P is connected to the battery terminal B^1, the other end of the primary being joined to the base of the vibrator pillar V P; the contact pillar C P base is connected to the battery terminal B^2.

The armature A on the vibrator should be of the same diameter as the core end, and of a length not less than half the diameter. A condenser K is joined between V P and C P. The condenser is usually fitted in the false bottom of the base. When the contacts are made the condenser is short-circuited. When the contacts are broken the extra current would, in the absence of the condenser, spark across the air gap between the contacts. The condenser is charged by this extra current, but immediately discharges through the primary in a direction reverse to the battery current, increasing the potential of the secondary current and hastening the demagnetisation of the core C. The capacity of the condenser should be such as to reduce the sparking at the contacts to a minimum, but not to entirely wipe it out.

The construction of the condenser is shown in skeleton form in Fig. 10. To start lay down four sheets of paper. Over them place a smaller sheet of tinfoil, with its edge projecting over the edge of the paper sheets for ½ in., the other edges of the paper sheet to be ½ in. wider than the tinfoil sheet. Add a single sheet of paper immediately over the other paper sheets. A sheet of tinfoil is now added, but with its edge projecting ½ in. over the opposite end of the paper sheets. Continue with alternate sheets of paper and tinfoil until the condenser is of sufficient size, finishing with four sheets of paper. Then place the whole in a hot oven until all damp has been driven off. Immerse in hot paraffin wax, allow to drain, and put under pressure until solid. Connect the projecting ends of tinfoil with wire to the base of the pillars V P and C P, as shown in Fig. 9. In Fig. 10 the thick lines represent the paper sheets, and the thin lines the tinfoil sheets.

Dimensions for ½-in. and 1-in. spark coils may be as given below, the dimensions of the 1-in. coil B being those of a coil specially made for general demonstration purposes, and giving splendid results.

Length of Spark	½ *in.*	1 *in.*	1 *in.* B
Core	5½ in. by ⅝ in.	7½ in. by ¾ in.	9½ in. by 1 in.
Bobbin diameter..	2⅝ in.	3 in.	2⅞ in.
Between cheeks	4½ in.	6¼ in.	8¼ in.
Primary, S.W.G. ..	No. 18	No. 16	No. 18
No. of layers ..	3	3	2
Secondary, S.W.G.	No. 38	No. 38	No. 38
Weight	¾ lb.	1¼ lb.	1¼ lb.
Condenser, tinfoil	5 in. by 4 in.	6 in. by 4 in.	7 in. by 5 in.
No. of sheets ..	50	50	100
Size of paper sheets ..	5 by 5	6 by 5	7 by 6
Battery, qt. size bichromate ..	3	4 to 6	6

APPARATUS FOR EXPERIMENTAL X-RAY PHOTOGRAPHY OR RADIOGRAPHY

The spark coil is one of the most important pieces of apparatus in the production of X-rays, although an induction machine could be used in its place. So many complicated and expensive improvements have been introduced into X-ray apparatus, and work of such extensive character has been done, that it is generally supposed that the apparatus is somewhat costly. This is not so, however, as the greater part of the apparatus can be constructed quite easily, and very interesting experiments conducted at a reasonable outlay.

When an electric spark is passed through a tube that has been partially exhausted of air, the discharge appears in the form of a purple glow at the anode (positive terminal), and, as the process of exhaustion is carried further, fills the whole bulb, afterwards becoming divided into striæ. On further exhaustion, an entirely new phenomenon is produced, and the tube (by which is meant any exhausted glass vessel) is called a Crookes' tube.

and it is with a Crookes' tube of special design that X-rays are generated.

Fig. 11 shows the simplest form of X-ray "focus tube." It consists essentially of a glass bulb which has been exhausted to a sufficient pitch (over $\frac{1}{20000000}$ of an atmosphere), in which two small mirrors are fixed. One is concave, and made of aluminium; the other is flat, and is made of platinum. The aluminium cup is called the cathode, and the flat platinum mirror the anti-cathode. When the electric spark is passed through this tube, it travels as a torrent of radiant matter from the concave cup, and impinges on the flat anti-cathode, which is set at its focal point. From this point an abundant supply of X-rays are generated.

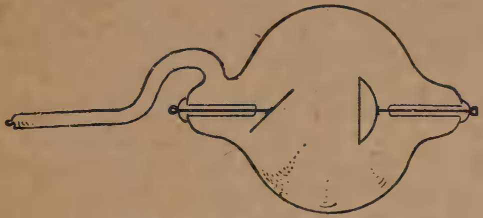


Fig. 11.—X-ray Tube

The tube cannot be made by the amateur, it can be purchased very cheaply second-hand; a small-size one (say $\frac{3}{4}$-in. bulb) can often be obtained for about three shillings.

The other necessary piece of apparatus is the machine to produce the discharge. This discharge is of a very high potential, and must produce a spark of at least $1\frac{1}{2}$ in. This may be obtained by means of a Wimshurst or Holtz induction machine or an induction coil. This part of the apparatus should be made, as, with a little ingenuity, a machine quite equal in power to a bought one is obtained at a trifle of the cost. The size of spark it is to produce must necessarily depend on the ability of the worker and the amount to be expended on it. But for X-ray work it must give at least $1\frac{1}{2}$ in. spark (the longer the better). Very interesting work, however, can be done with a 2-in. spark and a small tube. The smallest size of Wimshurst machine for this purpose would be one with two 15-in. plates. With this the writer has been able to get perfectly distinct radiographs of objects as dense as the human hand.

A holder for the tube is necessary, and this can be simply made as shown in Fig. 12. Although differing considerably from the ordinary tube stand, it is very convenient for small tubes. Two uprights, about $1\frac{1}{2}$ in. wide and 8 in. high, are fixed to a board $9\frac{1}{2}$ in. by 7 in. To each of these a piece $5\frac{1}{2}$ in. by 2 in. is attached at right angles to their face, so that they project over the baseboard. In each of these latter pieces a suitable notch is cut to receive the ends of the tube, so that the tube lies horizontally over the baseboard.

To take a radiograph, two well-insulated wires are run from the machine (if a Wimshurst is used, they are connected to the binding screws at the back, or in the case of a coil to the secondary terminals), and hooked on to the little brass terminals at the ends of the tube. The tube is laid in its holder with the flat mirror looking downwards. An ordinary rapid photographic plate is wrapped in black or light-proof paper, and laid sensitive side uppermost on the baseboard directly under the tube. (The paper is not light-proof to the X-rays.) On this the object to be radiographed is laid. A very convenient object to begin with would be a small bird or mouse, or a friend's hand. As soon as everything is prepared, the machine may be started. The tube should fluoresce a beautiful apple-green colour under the influence of the discharge, and if the wires are con-

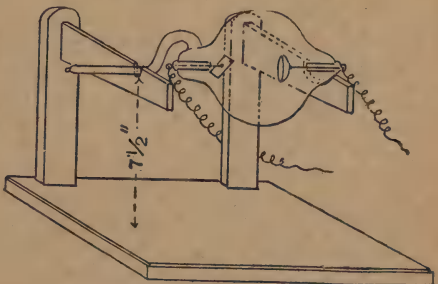


Fig. 12.—Holder for X-ray Tube

nected properly, the end at which the little concave mirror is placed should fluoresce more brightly than the other. If this is not the case, and there are patches of light in the tube, the wires must be reversed. The time of exposure will necessarily vary a great deal with the tube and size of spark the machine will give, but with a 2-in. spark coil the exposure for a small bird or mouse would be from 1 to 1½ minutes. This will easily be found after a few trials, and as soon as the initial difficulties have been overcome, a large field for experiment will be discovered although most probably radiographs of the thick parts of the human body, such as the head or abdomen, will be outside the scope of such small apparatus.

If a Wimshurst machine is used, the time of exposure should be prolonged on account of the intermittent nature of the discharge. The machine should be rotated to give a spark about every two or three seconds, for three or four minutes. It will be seen that no camera is required, and the plate is developed in the ordinary developing solutions.

No risks to health are entailed in the moderate use of *small* X-ray tubes.

A word of warning must be added about keeping photographic plates in the same room as that in which the apparatus is worked. If this is done the plates must be kept in a stout metal box, otherwise they will be ruined, materials other than metal being permeated by the rays.

Repairing Worm-eaten Chairs

A COMMON parlour chair was thought to be " not worth mending," especially as it was partly infected with woodworm.

Dowelling-in of New Chair Rail

Now, had the worms been all through the wood sufficiently to over-weaken it, the chair would certainly not have been worth restoring. But they chiefly confined their depredations to the front seat rail, under cover of the upholstery. This they utterly destroyed, until, being sat upon, it suddenly gave way and broke right out. The worms also encroached on the side rails and legs, but not to any serious extent. A new rail had to be put in, jointed by new dowels, and the other infected parts cured. First, the upholstery was carefully untacked from the old rail, and a new rail made exactly the same in birch instead of beech, because birch is never seen worm-eaten, whilst beech is the most susceptible of all woods. The old dowels were bored out of the side rails, and new ones glued in. This new work is shown ready for fixing in the illustration herewith.

It is well to warm the joint parts. Then, in a warm atmosphere, work hot glue, not too thick, inside or over the dowel holes, leg-pin holes, dowels, pins, and joint surfaces. Put together quickly and press close by cramping or knocking up with the mallet. Surplus glue should be wiped off with a rag wrung out of hot water. To make sure of the extermination of any grub in the other parts, a little paraffin oil is recommended as a simple home cure, to be run into the worm-holes by means of a small oil-can about once a month. When no new holes appear after a long period of time, the pest has most likely ceased to exist.

Casting in Plaster and Cement

THE processes of moulding to be described in this chapter apply both to plaster and to portland cement, but one or two differences should be remembered ; plaster sets rapidly, and is usually ready to be separated from the mould or matrix in an hour, whilst very considerably longer should be allowed in the case of cement. The last-mentioned, too, shrinks more than plaster, and this shrinkage should be allowed for in work where a good fit is required.

One of the simplest casting jobs to undertake is a panel in flat relief, and it will here be assumed that it is desired to take several casts from a model in the worker's possession. If there is no undercutting, as in the model shown in elevation by Fig. 1, it is obvious that the mould will lift off quite easily, without breakage ; but should there be undercuts, as in Fig. 2, it will be better to fill them in with clay as shown by the shaded parts of the illustration, and then the mould will lift off without difficulty, leaving an amount of work to be done on the cast itself. There are two broad classes of moulds : one, of plaster, that has to be chipped off the cast piece by piece, this being usually employed when only one cast is required ; and the other of gelatine, which can be used over and over again.

The casting of a clay relief in plaster is a comparatively simple matter. The process, briefly outlined, consists of first making a mould by covering the clay with wet plaster to a thickness of an inch or so. A little colouring matter added to the water with which the plaster is mixed will enable the worker to distinguish the mould from the cast in the after operations. When the plaster is hard, the clay should be removed from the mould, the latter being next cleaned, scraped, and oiled. Fresh plaster is poured into the mould, backed with canvas, allowed an hour or so to harden, and then separated from the mould by applying a chisel round the edge at the join of the two, when it will easily come apart if there is no undercutting, provided it has been well scraped and oiled.

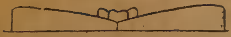


Fig. 1.—Model without Undercutting

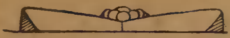


Fig. 2.—Undercuts Filled in with Clay

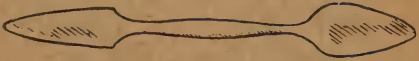


Fig. 3.—Plasterer's Mixing Spoon

CASTING FROM A PLASTER MOULD

The processes of casting a relief model in clay, in this case, a rosette, are shown by Figs. 4 to 11. Owing to the undercutting, the mould has to be chipped off in fragments, the colouring defining the two. But should several casts be required, it is better to fill the undercuts with clay, or to make the mould in two or more pieces, which are clamped together for use.

The clay model should be on a board, and have a strap of clay built up around it to keep the wet plaster from running off.

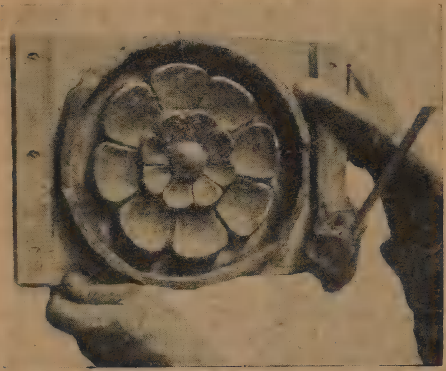


Fig. 4.—Model with Straps in Position

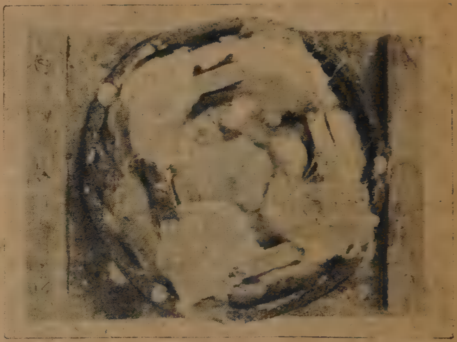


Fig. 5.—Model Reinforced with Strips

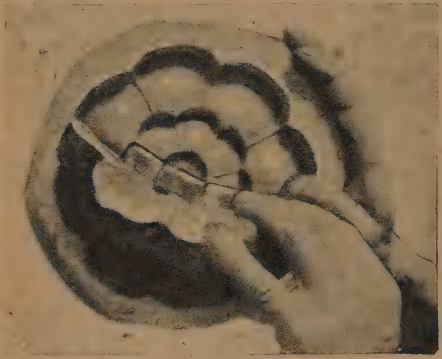


Fig. 6.—Separating Clay from Mould

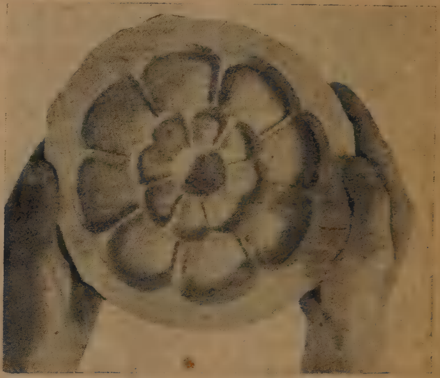


Fig. 7.—The Mould

Beat up a clay strap, damp the board, and affix in position as in Fig. 4.

Mixing Plaster.—Considerable judgment is necessary in mixing plaster, so that it may be sufficiently liquid to enter all the lines of the model, and yet have sufficient " body " to set hard. Thinly mixed plaster sets soft, breaks easily, and will not wear. Fill a medium-sized basin a little more than half-full with water, and add sufficient powdered yellow ochre to give it a deep yellow tint. Take the perfectly fresh plaster up with the hands, and sprinkle it in gradually, adding more plaster until it begins to settle at the top of the water. Clear away the plaster round the basin edge, and, with a plasterer's mixing spoon (Fig. 3) or substitute, beat up the plaster until it is of the consistency of thick cream, and without any lumps whatever. Good, but not superfine, plaster may be used for moulds.

Making the Mould.—Spoon a little first on to the deep hollows of the work, and blow it so as to expel any air bubbles in the interstices. Then lay an even coating all over, endeavouring to cover the work as equally as possible. Some workers prefer to scoop the plaster with their hands a little at a time, " flick " it upon the work, and then blow on it, so as to make doubly sure of getting rid of all air bubbles. This first coat is then backed up with plaster mixed more thickly, to make the whole about 1½ in. thick. Moulds of any size are reinforced with strips of wood or iron laid on the back and secured thereto with pads of tow soaked in plaster (see Fig. 5). The reinforcement is extremely useful, as, should fracture occur, the pieces are held together.

When the plaster has set, the clay strap is removed, and the model and its covering of plaster pulled off the board. It is now quite easy to separate the clay from the mould (see Fig. 6), although in the case of a model where there is undercutting considerable care is necessary to ensure the removal of the clay from all the crevices. The mould, which will now appear as in Fig. 7, is next well washed in running water with a brush, and then scoured with a mixture of soft soap and warm water (see Fig. 8) until the whole surface shines. The soap will serve as the separator between the cast and the mould, but the work must not be hurried, a half-hour's application being about right; the superfluous suds are then brushed off and the mould dried.

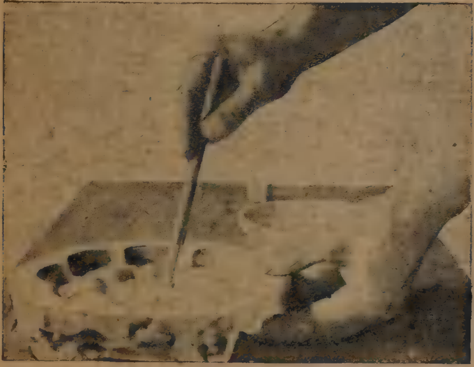


Fig. 8.—Soaping the Mould

Making the Cast.—The mould is now ready for filling, which process is shown by Fig. 9. Mix up some superfine plaster in a clean basin, and pour it into the mould, which should be rocked so as to distribute it. It is then backed with plaster mixed more thickly, and finally with a piece of coarse canvas soaked in plaster and laid over the back. After about an hour, the cast can be separated from the mould.

If there are no undercuts, a few light taps on a chisel applied to the join—that is, where the white plaster touches the yellow—should be sufficient to release it. If there is undercutting, the method of breaking off the mould in pieces, shown by Fig. 10, will have to be resorted to. The mould is placed on a soft bed, a folded sack answering quite well, and by gentle taps on the face of the work, the coloured plaster is broken off in pieces, the colour acting as a warning to the operator not to chip the cast, which would probably occur if the cast and mould were of one colour. A chisel ½ in. broad is a convenient size.

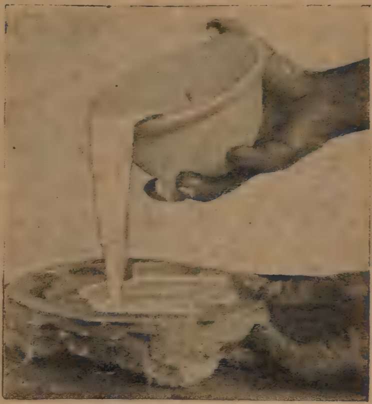


Fig. 9.—Filling the Mould

A painter's sash tool of medium size should be used to brush the fragments from the work occasionally to see the progress of the chipping. Needless to say, the brush must be kept scrupulously clean, or it will discolour the cast. Fig. 11 shows the finished cast.

CASTING FROM A GELATINE MOULD

When a number of casts is required, and there is a little undercutting, the mould is best made of gelatine. The work of making a gelatine mould from a model such as the boss illustrated by Fig. 12 will

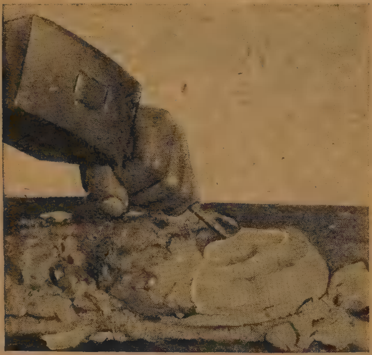


Fig. 10.—Chipping Off the Mould

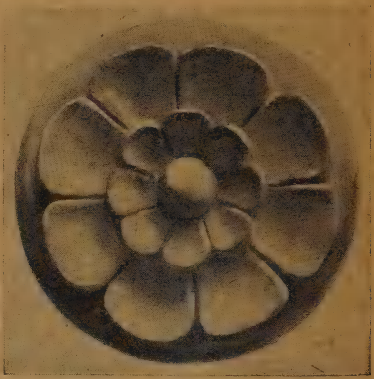


Fig. 11.—The Finished Cast

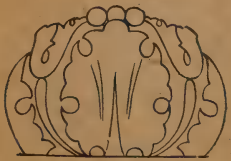


Fig. 12.—Boss to be Cast in Gelatine Mould

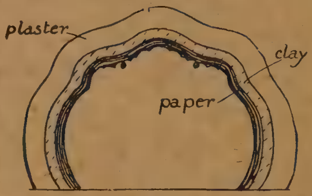


Fig. 13.—Section through Model, Plaster Shell, etc.

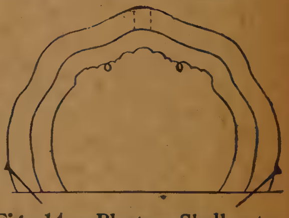


Fig. 14.—Plaster Shell, etc., ready for Filling with Gelatine

be described. The clay model, having been completed in detail, is left for a day or so to harden, and is then, with the board on which it stands, twice coated with french polish (a solution of 6 oz. of shellac in 1 pt. of methylated spirit). For making a plaster shell, with a space left between the model and the plaster for pouring in the melted gelatine, first oil the model all over, cover with two thicknesses of tissue paper, and then spread over this a layer of soft clay to make the whole about ¾ in. in thickness. Now spread over the clay some plaster mixed rather thickly to form a shell from 1 in. to 1½ in. thick. Fig. 13 shows a section of the whole at this stage of the work. After setting, a knife is passed round where the plaster comes against the board, and the plaster shell is removed, without injury to the model, which is left on the board. Next remove the paper and clay from model. Drill a small hole in the centre of the plaster shell (see Fig. 14), coat the whole with french polish, next, when dry, with oil, and place the shell carefully back in position over the model, securing it with a few nails which pass into the board (see Fig. 14). The space between the clay model and the plaster shell is now to be filled with melted gelatine, poured in through the hole in the top; but, before pouring, see that there are no crevices at the joint of the shell with the board through which the gelatine can leak. Pour carefully, leave plenty of space on one side of the hole for the air to escape freely as the gelatine is being poured in, and fill right up to the hole. After the gelatine has set, the plaster shell and gelatine are removed bodily, and any number of casts may then be taken. It will be understood that the undercutting indicated in Figs. 12 and 13 is rather exaggerated.

CASTING OBJECTS FROM THE ROUND

Making a Piece Mould.—The casting of an object in the round, such as a figure, presents more difficulty than a model in the flat. The successive stages of casting a figure, from the clay to finished model, are shown by Figs. 15 to 24. The mould is made in sections, usually (1) a large one that encloses the greater part of the figure, and (2) several small ones which serve as lids that can be removed from the main portions for pulling out the clay, cleaning, etc. The various pieces of the mould are shown by Fig. 20, A and B fit the large of the back shown at F (Fig. 19); C fits the opening at the top of the head; D fits the end of the right arm; and E fits the left arm. Fig. 15 shows the clay model and the first stage necessary for dividing up the mould. Clay straps are beaten up on a flat board, and cut into lengths. They should be about 2 in. wide, and ¼ in. thick, and they are applied to the model where the joints are to be. The strap round the head, and the one at the end of the right arm and a portion of the strap at the back, are clearly shown in Fig. 15. The parts of the model enclosed by the strap are next covered with paper to protect them, the main body of the mould being made first.

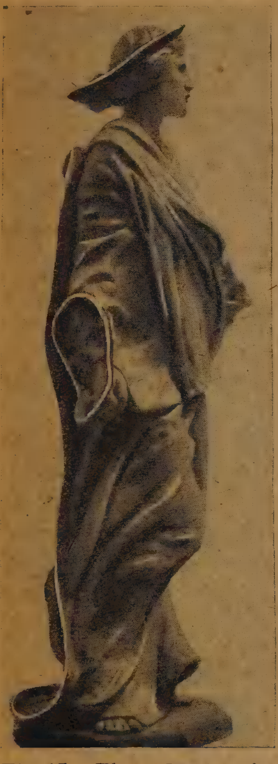


Fig. 15.—Figure Model with Straps in Position

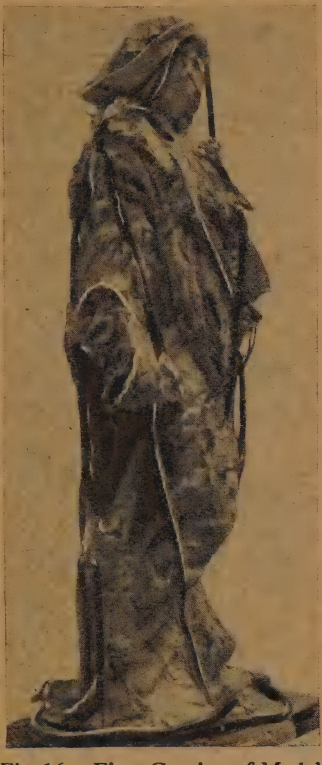


Fig. 16.—First Coating of Model, Showing Reinforcing Irons

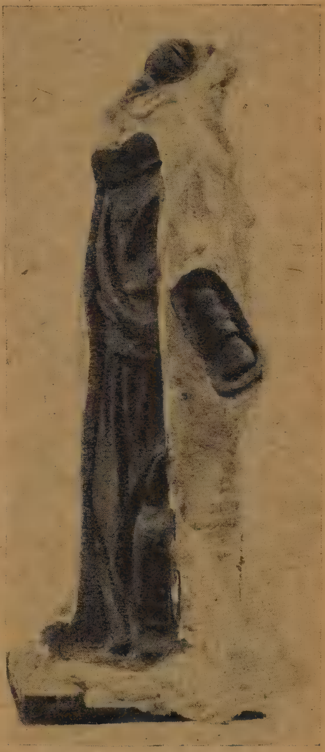


Fig. 17.—Mould partly Completed

Next, the parts not covered with paper are coated with plaster, coloured with ochre, to a thickness of about 1½ in., right up to the clay straps, taking care to fill the hollows first, and obtaining an even thickness as far as possible all over. The usual precautions are taken to expel air-bubbles by blowing into the crevices, or adopting the professional caster's plan of flinging on the plaster with the hands, so that no parts shall be missed.

In the case of a large model, as that

which is here illustrated, reinforcing irons are applied at this stage to preserve the work against breakage; $\frac{1}{4}$ in. or $\frac{3}{8}$ in. square iron will be found the most useful for the purpose. The irons are bent to take the lines of the model to some extent, to hold the whole together, and, in the case of a large model, they must not be omitted. They are clearly shown in Fig. 16; and before being used are heated and coated with brunswick black to prevent their rusting and discolouring the cast. They are temporarily secured with pads of tow soaked in plaster, but are ultimately covered in by a second coat of plaster laid over the whole.

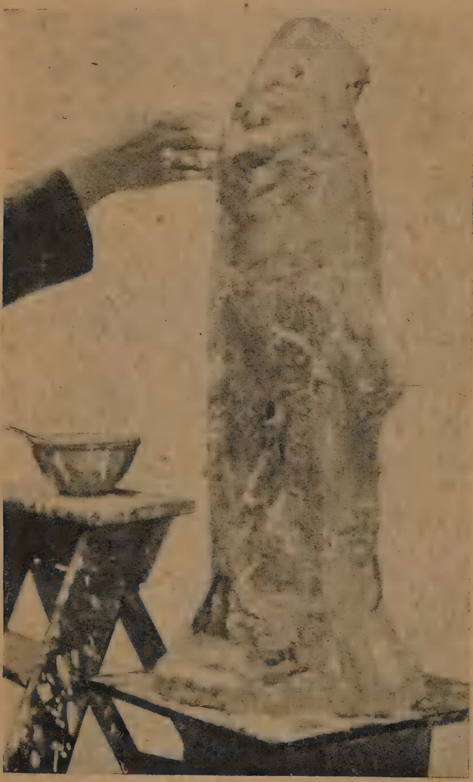


Fig. 18.—Completing the Second Coating

When the plaster has had time to set somewhat, the paper covering the smaller sections is removed, the model then presenting the appearance shown by Fig. 17.

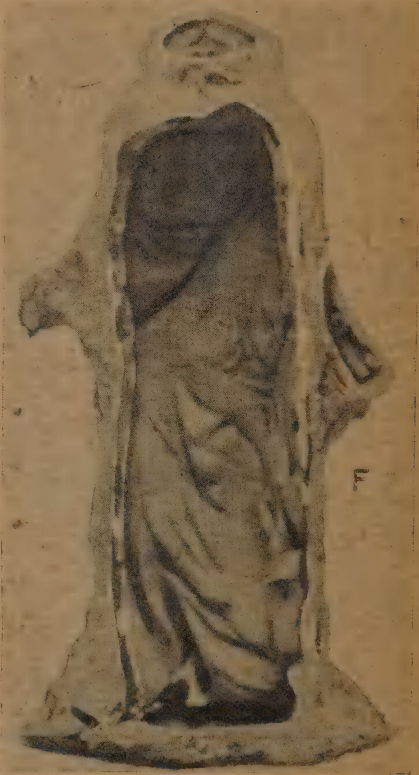


Fig. 19.—Part of the Mould

Now remove the clay straps, and with a convenient tool, such as the mixing spoon shown by Fig. 3, cut three or four shallow depressions on the edge of the plaster round each opening (see Fig. 21). In fitting together the sections of the mould later, these depressions and the button which will be formed on the edge of the adjacent section will ensure the mould being brought correctly together. Claywash the edges, and fill in the openings in the same manner as the main portion of the mould, and the figure will then be entirely covered, and present the appearance shown by Fig. 18, which shows the caster applying the last touches. After an hour or so has elapsed for the plaster to set, the smaller sections can be removed from the model by applying a chisel round the joins, which should be freely swilled with water; they are carefully laid on one side, the work now having the appearance shown by Fig. 17. The clay is then pulled out in pieces until the mould is empty, when it is lifted off the wood base and set under a tap to wash thoroughly. A painter's sash tool of fair size will be found as useful as any for the purpose, a smaller one being necessary for the deeper hollows.

Preparing the Mould.—The cleaning of the mould is a very important matter if a nice white cast is desired, and all pains should be taken to remove traces of clay from the plaster surface. Very often, portions of clay remain quite unobserved in some unobtrusive corner, and are not apparent until the plaster cast is actually made; so be careful to explore scrupulously all the remote corners especially, and so avoid trouble later. Figs. 19 and 20 show the sections of the finished mould.

After cleaning, make up a mixture of soft soap and water and thoroughly soak the mould with this. Brush it well in until the surface is thoroughly saturated and assumes a polish, and then remove the surplus. Set the mould up to drain, and well dry it with a brush, so that no suds remain in the hollows, and the surface is perfectly clean.

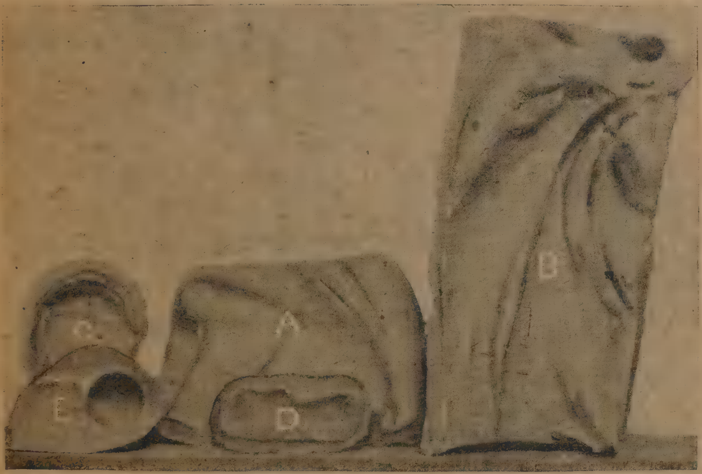


Fig. 20.—Portions of the Mould

The next process is the oiling, linseed oil being used and being applied with a clean brush all over the mould. The application of the soap in the first instance considerably lessens the suction of the plaster. The extremities of the oiled mould, such as the arms, are filled in with freshly-mixed plaster, strengthened with pieces of iron bent to the rough form, inserted through the apertures, and secured in position with plaster; it will be understood that the main body of the mould is filled from the bottom; but, before fitting the portions of the mould together, it is usual to fill the extremities first in case it should be difficult to run the plaster through to them.

Fig. 21.—Plan and Section of Depressions on Edges of Mould round Openings

Fig. 22.—Reinforcing Iron for Figure Casting

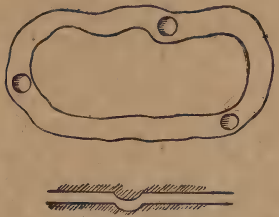


Fig. 21

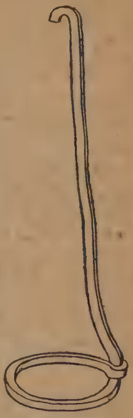


Fig. 22

The various portions of the mould are next fitted together and secured with pads of tow soaked in plaster placed at intervals along the joins. Frequently, where there are several large pieces to one mould, the sections are tied together and the ropes secured with tow. Stand the mould on the floor bottom upwards, and proceed to bend up a piece of iron, as in Fig. 22, to extend from the base to the head of the figure, the round part being a little less in diameter than the base. Run in a little plaster to fill the head, insert the iron (which should have been brunswick-blacked), and secure to the base with a little plaster mixed thick, which, when set, will hold the iron perfectly rigid.

Making the Cast.—For the actual filling, the services of an assistant will be a great convenience. The method is to mix a large basin of plaster to the consistency of thin cream, and pour it into the mould, which is then vigorously turned about in different directions so as to swill the plaster into every part, and the motion is kept up until there is no free plaster at the bottom of the mould. After a few minutes, the plaster will have partly set, and a fresh basinful can be poured in, and the swilling repeated until the cast has a crust about 2 in. thick.

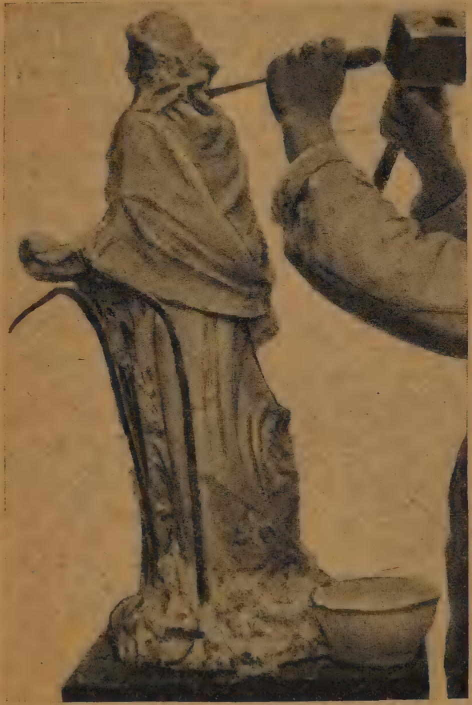


Fig. 23.—Chipping Off the Mould

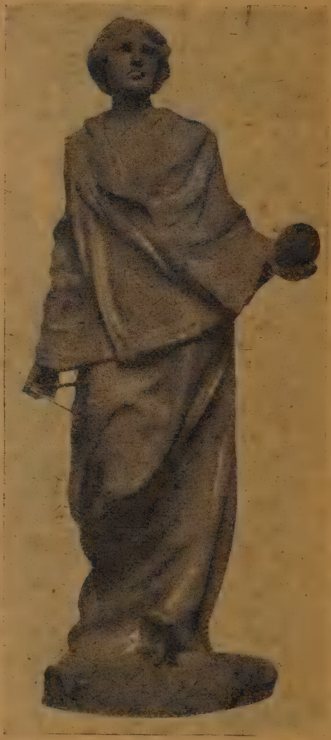


Fig. 24.—The Finished Figure

Chipping Off the Mould.—The work must now be left for an hour or two to get quite hard before proceeding with the next operation—that of chipping off the mould. This part of the work has imaginary terrors for the beginner, but really is not difficult, although requiring great care. The cast is stood up on its base, and, first of all, the pads of tow joining the sections are removed. Then with a broad chisel, try to prise off one of the small sections of the mould, at a place where it is known there is no undercutting. Then, when a portion of the face of the work is reached, the mould is broken off piece by piece with mallet and chisel, the coloured mould warning the worker not to chip at the cast, and it will be found to separate quite easily, if properly soaped and oiled in the first instance. Great care is essential, but slips are bound to occur and will have to be repaired afterwards. Fig. 23 shows a figure in the stage of being chipped out; the strengthening irons inserted in the mould can be clearly seen, and they must be worked round until they can be broken away. After the greater part of the mould has been chipped away, there will probably be many small pieces to be removed with a penknife or plasterer's tool, and then the necessary repairs are made by mixing up a little plaster, and applying it as required with one of the steel tools shown by Fig. 25, or by means of an old penknife. The mason's mallet shown in Fig. 26 is that most generally used by casters, but an ordinary one serves the purpose almost equally as well. Fig. 24 is a photograph showing the finished cast.

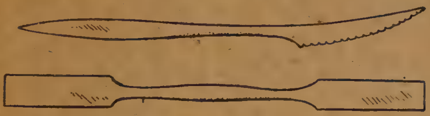


Fig. 25.—Plasterer's Steel Tools

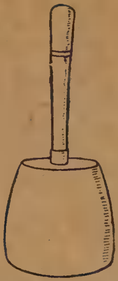


Fig. 26.—Mason's Mallet

Care in Preparing Glue

Many woodworkers utilise any old jar or tin as a glue-pot; but proper water-bath glue-pots are now so cheap as to bring them within the means of anyone, and no woodworker who wishes to produce good work can afford to be without one. A common mistake is to boil the glue too long; thus the setting properties are exhausted, and the glue becomes dark, and is rendered brittle. Fresh glue should never be added to the old in the pot. When the supply has been used up the pot should be emptied and cleaned out before refilling. Glue should never be heated in a pot exposed to the direct heat of a fire or lamp. Glue is extremely sensitive to heat, and, if once burned, it becomes useless. When a joint is being made, the glue should be applied rather thin, and sparingly. The pieces should be warmed sufficiently to keep the glue from chilling, but without making them hot. Too much heat will absorb the water suddenly, and leave only a very small residue of glue with scarcely any adhesive power in it. In some workshops it is customary to boil the cakes of glue until they dissolve; but this is a tedious and injurious method, and involves waste of fuel. The best plan is to break up the glue and allow it to soak overnight in plenty of cold water; it will then dissolve readily on the application of heat, without any waste occurring.

Glue loses much of its strength by repeated boiling.

There is a growing tendency to use liquid chemical glues—"Croid," for example—in place of the old-fashioned cake glues of animal origin. The newer glues were used in aeroplane construction during the war with remarkable success. They are put up in tin boxes and need no preparation.

Laying Linoleums and Mattings

In covering a floor with linoleum the consideration should be to have the work done with good taste and economy. Of course, the cost has to be considered, but it is a mistake to buy the stuff regardless as to whether it will look well, wear well, and best suit the purpose. Very "cheap" oilcloth may be very expensive in the end. Some of the low-priced oilcloths and linoleums have very glaring colours and obtrusive designs, and are best avoided altogether. Harmony in colour and design is a matter of individual taste and judgment, which may, however, be cultivated by observation and experience.

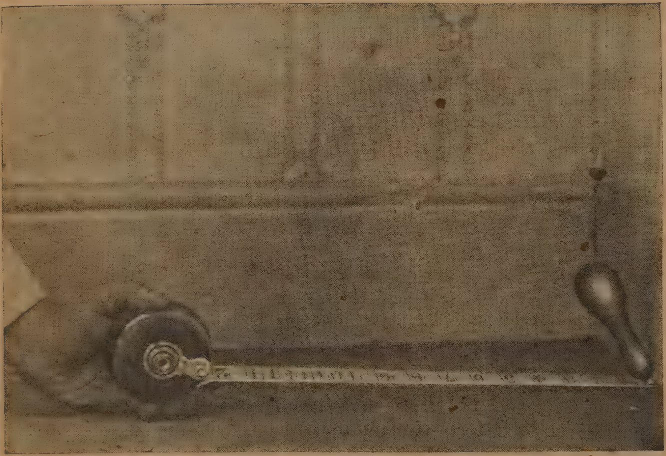


Fig. 1.—Measuring Floor with Tape

When selecting material for the rooms and passages of a house, some thought should be given as to what will harmonise with the decoration and furnishing of each room. One cannot go far wrong by keeping to neat designs and quiet colouring, and sometimes quite plainness is an advantage. Large, bold designs are useful on the floor of a large room sparingly furnished, but they make a small room look even smaller than it is. The linoleum manufacturers have introduced many small patterns especially suitable for use in small rooms.

The cheap oilcloths will last for many years in bedrooms with care; but to use them on floors subject to much wear is false economy, as they require renewing so often that the cost soon exceeds that of the best quality. A good quality oilcloth is more economical than a cheap linoleum. A good linoleum will stand considerable wear, but in time the pattern gets worn off and it looks very unsightly, but it may not be worn out in the course of several more years; it is improved if made quite plain by scrubbing off the remaining pattern with strong soda and water and sand, or it makes a good foundation for covering with a cheap material.

The inlaid linoleum, though expensive at first cost, is most economical for hard wear, as the pattern cannot be worn off until it is worn right through. It will stand much wear and always has a good appearance. It is particularly recommended for halls and living rooms. Ordinary linoleums are suitable for bedrooms, and they hardly ever wear out. If a soft, quiet tread is appreciated, then the cork linoleum will be preferred. There is a thick, plain variety of cork carpet especially suitable for bathrooms and passages. For these purposes the plain, self-colour linoleums are often used, the colours being brown, green, red, or mottled; sometimes they are used for bedrooms and for music-rooms, libraries, studies, etc., with rugs placed about the floor, and they are very useful also as carpet surrounds. The matting or parquetry designs also make good surrounds.

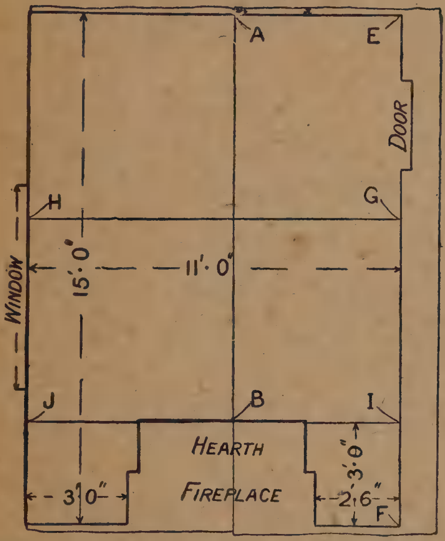


Fig. 2.—Plan of Room Floor, with Measurements and Details

For measuring floors, a 25-ft. tape measure is very handy, a short-bladed bradawl being stuck through the ring into the floor at the skirting board, and the tape drawn across to the opposite side (see Fig. 1). Generally, the measurements are taken the extreme length and breadth of the room; but it is better to draw a rough plan of the floor, marking the position of the doors, windows, hearth, and recesses, with the measurements. Each plan should be marked; Hall, kitchen, front bedroom—and so on.

A little study of these plans will show how to economise, and how to lay the stuff with the least cutting up. The design should grow from the view from the door of the room; but there are many reversible patterns which may be laid either way.

If the plans are drawn to scale it will be easy to make calculations from them, as it will only be necessary to apply a rule to find any measurements that may have been omitted. This mostly applies to irregular shapes, or in cutting for surrounds.

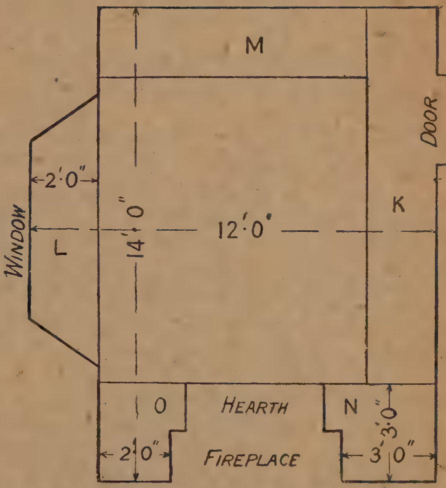


Fig. 3.—Plan of Room Floor with Bay Window; Margins will have a "Surround"

Average examples of room plans are shown by Figs. 2 and 3. From the plans and measurements it can be reckoned to an inch how much stuff is required; but something over should be allowed for matching the pattern at the join and for neat trimming at the walls, which are seldom quite straight and square with each other.

The plain stuff is the most economical, as the waste in matching is avoided, and it is quite straightforward to lay.

Take, for instance, the example shown by Fig. 2. When a workman is sent to measure such a floor he is usually "tied to time," especially when the linoleum is "laid free." He simply takes two measurements, length and breadth; and for plain stuff he would reckon the quantity to be 10 yd. of the double-width material, or 20 sq. yd. and about 6 in. over for fitting. He would therefore cut off the roll 30 ft. 6 in., to be laid in two pieces with one join from A to B. Fig. 4 shows the knife for cutting.

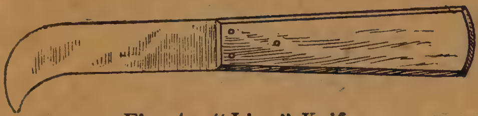


Fig. 4.—"Lino" Knife

In starting to lay, the stuff is first temporarily tacked in one corner, as shown in Fig. 5, then unrolled to the other end of the room, doubled over and partly rolled back to be cut off at C, leaving about 1 in. up the skirting-board for trimming. It is next cut along the edge of the hearth and right into the corner D. The other half of the stuff is then unrolled and laid out edge to edge with the other. It is then 1 ft. up the wall on the opposite edge, and this can be cut off to fit the wall neatly, beginning at corner E (Fig. 2), and cutting out to fit under the door up to the rebate and along to corner F. Then the hearth piece can be cut out and the rough cut edges trimmed straight. The centre join usually fits fairly neatly, but, if it should not, one edge is allowed to overlap the other to cut the under one to fit it, as Fig. 6 shows. The join is fixed with ½-in. sprigs (not with "tin tacks" having heads), and should be quite unnoticeable (see Fig. 7). No other fixing is necessary except at the door when it is fitted to the stuff on the floor outside.

Unless the stuff is very well seasoned (which new stuff seldom is), it should not be fitted too neatly on the outer edges, as it is almost sure to swell, and a good ⅛-in. space all round should be allowed, or it will rise in waves. Whenever convenient, it is best to leave it laid out on the floor a few days before fixing.

Now, it will be seen that this is a practical and expeditious way of doing the work, but there will seem to be considerable waste. By studying Fig. 2, it will be seen that the stuff cut from the hearth-place, together with a long strip 15 ft. by 1 ft., amounts to about 3½ sq. yd., and if it had a fairly large design, another ½ yd. of the double width might have to be allowed for matching. The cost of this waste might be anything between 6s. and £1, according to quality, and that is only one room.

There are ways of saving this, but there will be more cutting and joining, though this is no detriment when well done. One way is to buy 4 sq. yd. less, lay it only as far as the hearth, and cut up the long strip to fill in the two recesses. Another way, with the same quantity, is to run it *across* the room. It will then be in four pieces, the joins being from G to H and from I to J. This latter method may be necessary for appearance sake in laying stuff with a design growing one way.

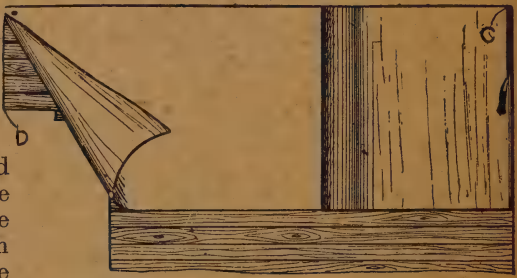


Fig. 5.—Unrolling Linoleum on One Half of Floor

It will be easily understood that on several rooms as much might be saved as would buy a good carpet. It is well to save cuttings to repair with, but very few persons care to store them for years, preferring to buy a bit when it is required, though there is the chance of the pattern going out of date. There need be no waste with plain stuff, except small scraps; but with designs there must be some cutting away in matching joins. The smaller the design, however, the less is the waste.

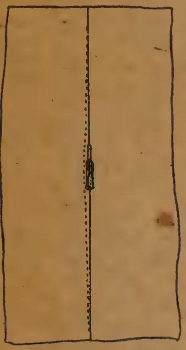


Fig. 6.—Fitting Edges for Joining

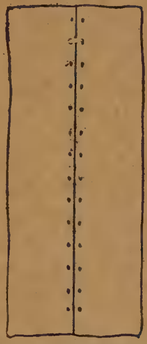


Fig. 7.—Arrangement of Brads at Joint

Fig. 3 shows an example of a simple surround. For this purpose the plain linoleum is recommended, and if a suitable tint is chosen it enhances the appearance of a carpet considerably. Dark blue goes well with most carpets, but it is well to exercise one's own taste. The stuff can be obtained only 2 yd. wide, to be cut to the width required, but there are some special narrow widths *with* designs.

In this case a little calculation on the plan shows that the quantity is $4\frac{1}{6}$ yd., but it will be well to get $4\frac{1}{4}$ yd. to give more freedom in cutting. It should be marked out as shown in Fig. 8, for which purpose a long wood straightedge will be required, and this is also useful as a guide for the knife in cutting. The recess piece O is in two pieces, to be joined. It is best to cut them a trifle large, to be neatly fitted when in place. The joins should be cut so true as not to show, and must be fixed with the brads; a few brads along the edges of the pieces keep them from shifting. (In Fig. 8, letters indicate pieces required for room shown by Fig. 3, p. 379.)

The width of a surround will be determined by the size of the carpet square. Any suitable material may be used, but there are special patterns and widths for the purpose; and it is often necessary to mitre the joins at the corners to match the pattern, thus necessitating more stuff.

A common mistake which amateurs often make is to use tacks instead of the brads or sprigs, and too many of them. The tacks with heads are very unsightly, but the brads cannot be seen, and when linoleum has to be taken up to be re-laid elsewhere it can be pulled up with ease from the brads.

A good lasting quality of stuff may be re-laid many times, and in re-fitting it gets cut up into many pieces; yet by matching the pattern and good joining a floor may be covered in, a score of pieces all appearing as one.

The inlaid quality is sometimes rather difficult to lay, especially in frosty weather, as it gets brittle and cracks; but a fire in the room will make it much more pliable, or washing it over with hot water will serve the same purpose. In any case, it is the most difficult stuff to manage, but it is well worth the trouble of cutting and laying, even if a floor has to be covered in many pieces. Fig. 9 shows how to cut a crooked edge straight, using the wood straightedge as a guide for the knife point. The stuff being hard and thick may be only slightly cut when the point of the knife has been drawn over once or twice, so the cutting is finished with the edge of the knife, parting the stuff with the fingers to ease the work, as in Fig. 10. It is sometimes convenient to cut from underneath, the point of the knife projecting through the linoleum. Another way is to double it back, cracking it along the cut mark, when it will cut with ease.

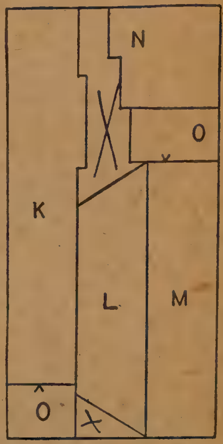


Fig. 8.—Material for "Surround" (see Fig. 3) Set out on Linoleum

In making a join, the pattern should always be matched. To do this the straight

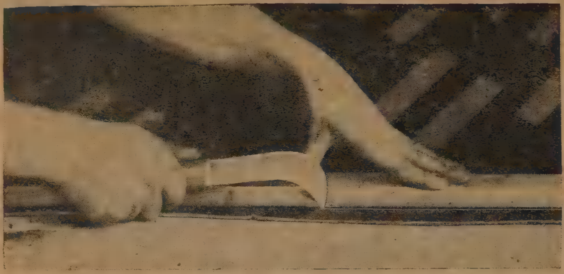


Fig. 9.—Marking with Knife and Wooden Straightedge

cut edge is laid over the one to which it has to be joined, matching the pattern and temporarily fixing with a few tacks partly driven to keep it from shifting; then, as in Fig. 11, it is cut along the edge. To get on quickly with the fixing, both hands must be actively employed, one placing the brads whilst the other hammers them in.

It is always as well to endeavour to make the joins at the least conspicuous places, whenever possible following the lines of the design, or through the dark parts, as Fig. 12 shows, in which the join is made diagonally through the black squares; but it would have been better still if it could have been cut along the lines of the pattern.

It is often desired to patch linoleum that is laid on the floor where it is worn or damaged, and this can be done very effectually. Assume that good quality of linoleum has been damaged by a broken caster. The damaged part is marked out in chalk and measured. A piece of stuff is obtained to match the design, laid over the damaged portion and temporarily tacked, Fig. 13 showing how the edges are used as a guide for the knife in cutting out the damaged part. The good piece is let in level and fixed with brads.

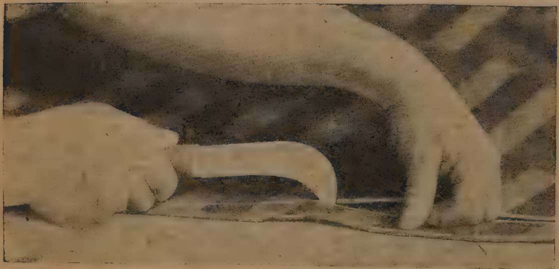


Fig. 10.—Downward Cutting to the Marked Line

SHARPENING LINO KNIFE

The knife requires frequent sharpening, and for this purpose is kept a piece of wood about 8 in. by 2 in. by 1 in. with emery-cloth wrapped round and tacked on the edge. One side of the block should be rounded (see Figs. 14 and 15). The knife is rubbed on this block as required. If wished, finer or coarser emery-cloth may be fixed on the other side.

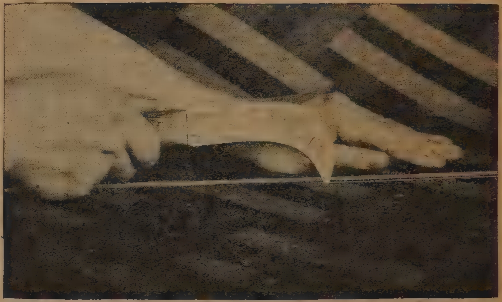


Fig. 11.—Cut-marking for Making a Matched Join

LAYING MATTING

It is sometimes desired to cover a floor with a medium material between linoleum and carpet. For this purpose there are various kinds of matting, both plain and fancy. The usual width is 1 yd. Mattings are manufactured in rolls so that any length may be cut. The cut edges must be bound. Frequently it will be found cheaper to buy some of the Chinese matting rather than common oilcloth.

To cover a floor with matting the required number of lengths must be cut and bound and laid edge to edge, being fixed with drugget pins. Sometimes matting is made in the form of a carpet square by stitching the edges

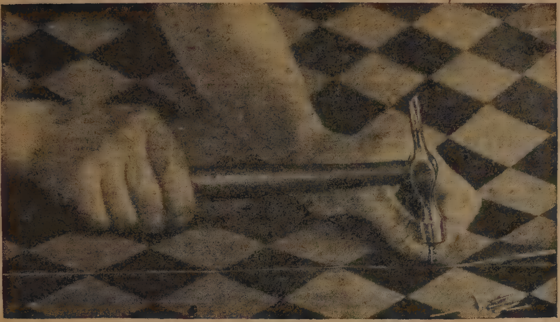


Fig. 12.—Joint Line in Dark Part of Linoleum

together, the floor margin being then stained and polished. Matting has the advantage over oilcloth of being quiet to the tread, and is often employed on floors of studies. It is in vogue for bedrooms, as it is considered sanitary.

LINOLEUM CEMENTS AND PASTES

Where there is no objection, linoleum or oilcloth may be fastened to the floor with cement or paste, but tenants' leases and agreements often prohibit the use of an adhesive between linoleum and wood floors, since the floor covering then tends to seal the air space under the boards and so prevent any circulation of air round the woodwork, thus encouraging fungus growths which sap the life of the timber.

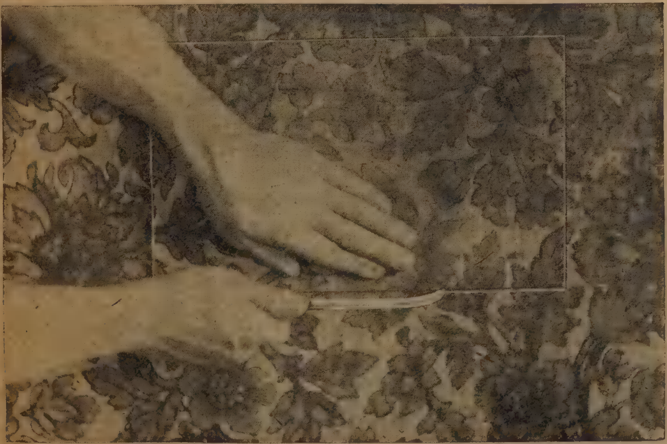


Fig. 13.—Using Tacked-down Piece of Linoleum as Guide for Knife

Dry-rot scarcely ever appears in well-ventilated situations. Where no trouble of the sort is likely to ensue, either cement or paste may be employed. A good cement is made with 2 parts of glue, 1 part of black treacle, and 1 part of pitch. Having soaked the glue overnight in cold water, boil up, and add the treacle; then break up and melt the pitch, and add to the other mixture while hot. It should be used warm. By adding a small quantity of bichromate of potash, the mixture will be almost insoluble after it has set; but if this is done, care should be taken not to prepare more than is likely to be wanted for immediate use, as it will not work up a second time.

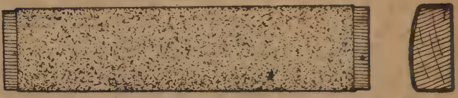


Fig. 14

Fig. 15

Figs. 14 and 15.—Plan and Section of Knife-sharpening Block

Stone and tiled floors require fluid or semi-fluid cements. Dextrine is the foundation of most of these, and may even be used alone in places that are not too dry. To obviate the separation that usually arises from excessive dryness, add 2 oz. of glycerine to 1 lb. of dextrine. Mix them well together, adding a few drops of oil of cloves to prevent decomposition.

For paste, mix rye flour with a little cold water, then add some water that is quite boiling, and well stir the paste while the water is being poured in. Melt some glue size and add to the paste while both are hot. Stir well. The more size is added the greater the strength of the paste. (As a rule, "inlaid" linoleums require very strong paste.) A little alum dissolved in the paste, or oil of cloves added to it, is a preservative. If the paste is too thin, boil it so as to evaporate some of the water.

A method of keeping water out of floor joints is to cement the linoleum firmly to the floor for about 3 in. on all edges. The edges against skirtings, fireplaces, doorways, etc., should be carefully treated. A waterproof cement for the purpose is as follows: Dissolve in a sufficient quantity of bisulphide of carbon 100 parts of finely chopped indiarubber, 15 parts of resin, and 10 parts of shellac. The cement should be about the consistency of treacle.

LAYING LINOLEUM ON STONE FLOOR

It is often difficult to cover a stone or flagged floor with linoleum, owing to the flags being worn and uneven, which causes the linoleum to crack. The dampness, also, will quickly rot the linoleum. These drawbacks may be obviated by adopting the following method, which ensures a smooth, even surface for the linoleum. Fill up all cracks and uneven places with sawdust, and spread the sawdust evenly to a depth of about 1 in. over the whole floor, using for this purpose an ordinary soft broom. Place over the sawdust some thick paper-felt, procurable from most dealers in linoleum, 4 ft. 4 in. wide. When laying the paper, keep any joints in it a few inches away from the joints or seams in the linoleum, as otherwise a little sawdust may find its way through. The linoleum is then laid over the paper and, if possible, left loose on the floor for about a fortnight before pasting down, so that it may stretch. Use a freshly-made paste of thin glue and wheaten flour, a thick coating being given to the edges of the seams, which are afterwards pressed down into place on the paper felt; then the edges, along the skirting boards and in the doorways, are treated in the same manner.

INCREASING DURABILITY OF OILCLOTH

Inlaid linoleum lasts a lifetime and does not need preservative treatment other than an occasional rubbing with a cloth to which has been applied a very little beeswax and turpentine. If much wax is used, the linoleum becomes as slippery as a ballroom floor, and such a condition is extremely dangerous in the home.

Cheap oilcloth is improved by treating its back in such a way as to resist damp and provide a stronger basis for the printed surface. Lay the oilcloth bottom upwards on the floor, and then well stretch it and tack it down. Mix together equal parts of red oxide paint and red lead with a little patent driers, thin down with boiled oil and turps to the required consistency, and add a little oil varnish. Give the oilcloth two coats of this paint, allowing the first one to dry thoroughly before applying the second. Now turn the linoleum over, pattern side up, and tack it down as before, then give two coats of hard durable oak varnish; but if there are any white or delicate colours in the design, use a pale or colourless copal varnish.

REMEDYING CASTER IMPRESSIONS IN OILCLOTH

Heavy furniture often makes impressions in soft oilcloth, one way of remedying these being to fill them with a mixture of equal parts of boiled oil and varnish thickened with whiting, and tinted by adding a little dry colour. When this is thoroughly dry, two coats of hard oak varnish should be given all over to harden the surface of the cloth. The varnish should be allowed to dry for about fourteen days before anything heavy is placed on it. If floorcloth is varnished once a year it will be found to be as durable as linoleum; it needs to be washed and allowed to get *thoroughly* dry before varnishing.

PRINTED IN ENGLAND BY CASSELL & COMPANY, LIMITED, LONDON, E.C.4.

[redacted]

Jones
The amateur mechanic

DATE DUE

DEMCO 38-297

1934
1941

Baker & Taylor
385

ABL-3018

BUTLER UNIVERSITY LIBRARIES
0 1180 0177283 9

TJ7 .A42 v.3
SCIENCE

The amateur mechanic : a
practical guide for the
[19--?].

DEMCO